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The New York Central Railroad Co. is about to build extensive shops at a point on the line about ten miles from Buffalo. A tract of about 1,500 acres has been secured, and the work of construction is to commence at once. Repair shops will first be built; but a complete plant for locomotive building will eventually be added, and employment given to about 1,200 men. This new village is to be called Depew.

The Third Avenue Cable road, in this city, work upon which was lately abandoned by Mr. William Wharton, is to be completed by Mr. Thos. E. Crimmins, brother of Mr. John D. Crimmins. The contract figures are not given, but it is understood that the cost will much exceed the original estimate of $1,600,000. The track is now practically completed between 9th and 124th Sts. The work to be done lies between Ann and 9th Sts., and from 124th to 130th Sts.

The eight or nine mile depths in mid-ocean, declared very probable by Maury, are not found by later actual investigation. A depth of five to six miles is very exceptional, and the average appears to be about 2,500 fathoms for the waters of the globe. The greatest depth yet found is 4,575 fathoms (5.2 miles) south of the Ladrones, and 4,561 fathoms north of Porto Rico, near St. Thomas. The deepest sounding, then, in the North Atlantic, is 4,561 fathoms, and in the South Atlantic bottom is always found at a less depth. The Mediterranean gives 2,150 fathoms as a maximum to date, and the deepest known water in the Indian Ocean is 3,190 fathoms. The Polar basin seems to grow shallower as the North Pole is approached, and bottom was found at 72 fathoms in the most northern sounding made. These soundings, so far as made, also disprove the theory that the ocean bottom is a counterpart of the dry land in its irregularity of surface. It has its peaks and deep gorges, but as a rule, the surface lies in very gentle undulations, without abrupt or steep slopes.

An irrigation canal, 25 miles long, is to be constructed over the Roman Campagna, between Rome and Tivoli. This canal would be supplied with water from the River Ariene, which flows at an altitude of 696 ft. above sea level at Tivoli, and descends 328 ft. at the celebrated falls of that name. The canal would take water from the foot of the falls, or 368 ft. above sea level, and, following the higher parts of the Campagna, would make splendid pasture lands, by irrigation of what is now a parched district. When the canal reaches Rome it will still be 245 ft. above the Tiber, into which it is to discharge, and this head is to be utilized for power, with a calculated efficiency of about 8,000 HP. The cost of the canal is estimated at $2,200,000 by Sig. A. Vescovali, the engineer. The concession for the work has been granted to James Wilson, of London.

Nitro-jute is a new explosive, invented by Mr. Otto Muhlhauser. He treats one part by weight of jute fibre with 15 times its weight of a mixture of nitric and sulphuric acids. This product, which weighs about 30 per cent. more than the original fibre, takes fire at a temperature of 167 to 170 degrees C., and contains about 12 per cent. of nitrogen. It is of a brownish-yellow color, and the composition is given by the author as C12, H15, O5 (ONO2). It explodes by percussion like gun cotton, and is insoluble in water, ether, benzine or alcohol, but dissolves readily in acetic ether and nitro benzine.

The most serious railway accident of the week was a derailment, March 11, on the Illinois Central R. R., near Jackson, Miss. The accident was caused by malicious loosening of the fastenings of a rail. The engine and cars, with the exception of two sleeping cars, went down a high bank, but nobody was killed and only four men were injured.—A serious rear collision of freight trains occurred March 14 on the New York Central & Hudson River R. R. near Yonkers, N. Y. The first section of a freight train was stopped at a switch, but the rear brakeman did not go back far enough to flag the second section. Several cars were wrecked, and one was burned. The wreck blocked the four tracks, causing much delay to traffic.

A trestle on the Lake Erie & Western R. R., over the Salamonia River, near Celina, O., gave way under a derailed freight train Feb. 24, and 14 cars were wrecked. The trestle had seven spans of 16 ft., and was three years old.

A locomotive boiler explosion occurred March 16 at McAuley, on the Catawissa branch of the Philadelphia & Reading R. R., killing two and injuring three men.

The contract for the Harlem River drawbridge and eastern approach at 155th St., has been awarded by the New York Department of Public Parks, after some unusually close bidding, to the Passaic Rolling Mill Co., at $1,102,531. Mr. A. P. Boller, M. Am. Soc. C. E., is the engineer. A full table of the prices bid, for 48 different kinds of work, is given on another page. The following table shows how very close the total amounts were, the second column giving the proportions, the lowest being taken as 100:

	Totals. bids;	Proportion of lowest, 100
Passaic Rolling Mill Co...	$1,102,531	100.0
Union Bridge Co.	1,150,452	104.3
Arthur McMillan.	1,162,570	105.4
King Bridge Co.	1,176,633	106.6
Hart, Anderson & Barr....	1,186,874	107.5
T. & A. Walsh.	1,202,004	109.1

The deepening of Canadian canals to 20 ft. is not likely to be carried out. In answer to the proposition to deepen the Welland and St. Lawrence canals to this depth, so as to enable ocean steamships to pass on to Duluth and Port Arthur, the Minister of Railways and Canals gave the following as the opinion of the Government: "The depth proposed was impracticable, as the obstructions in the St. Lawrence were almost insurmountable, and the lowest estimate of cost was found by the Government to be $77,000,000 for 20 ft. of water and proper harbors along the route. The Government had decided that it was cheaper and better to continue to use smaller vessels and transship into ocean carriers The motion before Parliament to deepen the canals was withdrawn.

The Lick Observatory, on the summit of Mount Hamilton, and about 4,000 ft. above the sea, had 1,350 acres of land granted to it by Congress in 1876, and 191.5 acres were afterwards added by purchase. The citizens of San Jose spent $78,000 in building a magnificent wagon road to this hitherto almost inaccessible spot. But the Observatory wants more land under its control so that it can stop hunters from building camp-fires and starting forest fires with their clouds of smoke. The present Congress has therefore passed a bill adding 608 acres to the reservation and the United States Senate will doubtless also concur.

Nickel-steel armor plates, of English make, are discussed in the late report of Lord Hamilton, First Lord of the Admiralty. Two firms have produced 10 1-2-in. nickel-steel plates, and their tests are said to compare favorably with those of the same type of plate made in other countries. Extensive orders have been placed for the use of this armor in the secondary defense of battle-ships. But for greater thicknesses than three or four inches, says Lord Hamilton, the inquiry is not yet sufficiently complete to warrant its adoption. Its manufacture is, however, being widely extended under the liberal patronage of the British Admiralty.

Coal gas for car lighting is used on the North London Ry., of England, as described in our issue of May 16, 1891, and an improved form of lamp introduced by the Lamp Mfg. Co., of London, is now being tried. The gas reservoirs being at the ends of the train, the pressure of gas in the middle of the train is considerably less than at the ends, and the lamps in the middle cars are more liable to be extinguished by drafts. This difficulty is said to have been overcome in the new lamps.

The gross earnings of 140 railways operating 94,397 miles of road for the month of February are $39,068,578. This is an increase of 2.48 per cent. in mileage and 13.43 per cent. in earnings over the corresponding month of 1891. This result is especially gratifying considering the poor showing for the previous month, and is largely due to the heavy grain and cotton movements. The greatest gains are shown by the grain carrying roads, together with a few of the Southern and coal roads. With the exception of the South all sections of the country show very favorable results. The most striking improvements are in the Northwest, Southwest, and Middle and Middle Western groups. There are 45 roads showing increases of over $30,000 each, and but one, and that a foreign line, showing a decrease of that amount.

Consolidation freight engines recently built by the Rogers Locomotive & Machine Works, Paterson, N. J., have Belpaire fire-boxes with fire-brick arches, and are intended to burn soft coal. The main driving wheels have blind tires. The leading dimensions of these engines are as follows:

Cylinders	21x24 ins.
Diameter of driving wheels	4 ft. 8 1-2 ins.
Diameter of truck wheels	2 ft. 9 ins.
Diameter of boiler	5 ft. 2 ins.
Form of fire-box	Belpaire
Size of fire-box	2 ft. 9 ins.x10 ft. 2 ins.
Boiler pressure	165 lbs.
Tubes, number	236
Tubes, diameter outside	2 ins.
Tubes, length	11 ft. 10 ins.
Grate area	28 sq. ft.
Heating surface, tubes	1,482 sq. ft.
Heating surface, fire-box	171 sq. ft.
Heating surface, total	1,653 sq. ft.
Driving wheel, base	16 ft. 9 ins.
Total wheel base	24 ft. 5 ins.
Weight on driving wheels	118,600 lbs.
Weight on truck	18,700 lbs.
Weight total (in working order)	137,300 lbs.
Capacity of tender tank	3,850 gallons.
Brakes—Westinghouse automatic for tender and train, and American driver.	

Copper and German silver wire, .002 in. in diameter, is made in Providence, R. I., with the aid of dies made of drilled diamonds with the hole reamed smooth. This wire, of which it takes 16 miles to weigh a pound, says the N. Y. "Sun," is used in the receiving instruments for ocean cables, galvanometers for testing cables, etc. Small as the wire is, it is wound with two layers of silk thread smaller in diameter than the wire. The diamonds used are chips from larger diamonds, obtained in diamond cutting, and they are set in brass and held by an alloy. Rubies and sapphires were first used, but were found to alter their form in use.

The electric welding of street railway rails, as a substitute for fish-plates, has been the subject of experiment for some time at the works of the Johnson Rail Co., at Johnstown, Pa. The experiments are now said to be entirely successful, and it is possible to weld by electricity two pieces of steel of 25 sq. in. section, and a solid steel rail, three or four miles long, can be had if required. The tests also are said to prove that the necessity of joints to provide for contraction and expansion is not so apparent as supposed by engineers.

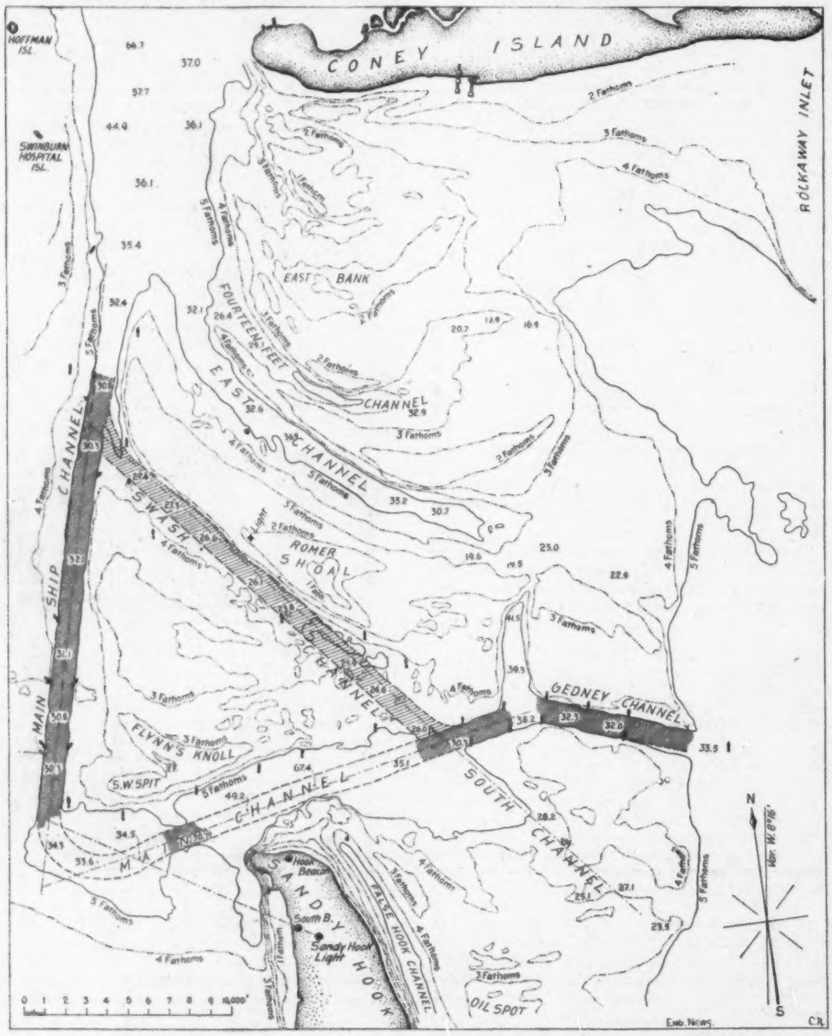
The total number of immigrants entering the United States from other countries than British North America and Mexico, for the year ending June 30, 1891, is given as follows in the last annual report of the Secretary of the Treasury: Total for 1891, 560,319, as compared with 455,302 in the preceding fiscal year. Of this number for 1891 Germany sent 113,554; Italy, 76,055; Russia and Poland, 74,923; Austria-Hungary, 71,042; Sweden and Norway, 49,448, and Denmark 10,650. England sent us 53,600 immigrants; Scotland, 12,557 and Ireland, 55,706. France sent us only 6,766 in the year, and China is credited with 2,836. Of the total first given 448,403 landed at the port of New York, and Baltimore comes next with 40,604.

Medusaline sidewalk contracts, to the extent of 450,000 sq. ft., for the World's Columbian Exposition, have been awarded to the Medusaline Manufacturing Co., of Chicago, Ill. The same company also has the contract for making by their patent process about 250,000 sq. ft. of the roof of the Fisheries Building. Medusaline is a new material now being manufactured for the above, and many other purposes, and a full description of it will appear in a future issue of this journal.

IMPROVEMENT OF THE ENTRANCE TO NEW YORK HARBOR.

Among the practical papers lately submitted to the American Society of Civil Engineers is one by Mr. Joseph Edwards on the above subject. Mr. Edwards writes from the standpoint of a good work accomplished, and details his experience and the results gained. Space forbids the full printing of this valuable paper, but its chief points will be found in the following abstract:

Commencing by calling attention to the great importance of an improved entrance to the harbor of New York, Mr. Edwards shows the conditions lately existing. The lower bay of New York Harbor is a tidal basin with an area of about 100 sq. miles.



MAP OF LOWER BAY, NEW YORK HARBOR, SHOWING ENTRANCE CHANNELS, SOUNDINGS IN FEET AND CONTOUR LINES AT 2, 3, 4 AND 5 FATHOMS.

(The dredged parts of Main Ship Channel are shown by close diagonal ruling. The Swash Channel is indicated by open ruling.

The distance from the Battery to 30-ft. soundings outside the bar of Gedney's Channel is 22 miles. by the main ship channel, and 18 miles by the Swash Channel. Counting from the Narrows, north of which to the city there is nowhere less than 30 ft. in the main channel, the distance to 30 ft. of water outside is 15 miles.

There were four obstructing shoals between the ocean and the Narrows in 1890, as follows: (1) The outer bar, about 4,000 ft. wide, with Gedney's Channel crossing it with 23.7 ft. of water in midchannel and 22.3 ft. in the southern half. (2) The shoal at the mouth of the Swash Channel, 4,000 ft. wide, with the Bayside Channel crossing it with 24.3 ft. of water. (3) The shoal northward of Sandy Hook, about 2,000 ft. wide, with a least depth of 26.2 ft. (4) The shoal in the Main Ship Channel in the Lower Bay, west of Flynn's Knoll, nearly 3 miles long, with a crest depth of 23.9 ft. in midchannel, and 22.6 ft. within a few hundred feet of this.

Major Gillespie, in 1884, reported that the deepest draft vessel that had to that time entered New York Harbor was the Spanish frigate "Numancia," drawing 28 ft. 8 in., and entering on a spring tide. The largest ocean steamers now require 30 ft. at mean low-water to enable them to come in with 2 ft. to spare below their bottoms. The mean rise of tide in the bay is 4.8 ft.

No action was taken by the general Government to improve the entrance to New York Harbor until July 5, 1884, when $200,000 was appropriated for deepening Gedney's Channel, and the engineer officers were ordered to make surveys and plans. Major G. L. Gillespie, in charge, as a preliminary work proposed to make a cut across the bar 4,000 ft. long, 1,000 ft. wide, with 30 ft. of water at mean low stage, and he estimated that the maximum cutting would be 6 1-2 ft., and figured the amount of material to be moved at 700,000 cu. yds. The estimated cost for Gedney's Channel alone was $350,000. He recommended that the Main Channel west of Flynn's Knoll be also improved in a similar manner at a cost of $620,000. Various plans of work and estimates of cost followed, and for a long time the question of contracting the channel by stone dikes, at an estimated cost of $4,500,000, was discussed. But the money spent in dredging in Gedney's Channel foreshadowed the possibility of accomplishing all desired results by dredging alone. The Board of Engineers therefore recommended that the dredging operations should be extended.

By November, 1886, 303,809 cu. yds. had been dredged from this channel, and the report of Major McFarland, in 1887, showed that in the eight preceding months the increased depth had been maintained in the face of storms and cross currents. The reports of 1888, 1889 and 1890 showed similar happy results as the dredging progressed, and Major Gillespie, in 1890, reported that there was 30 ft. of water in Gedney's Channel at mean low-water for the full width of 1,000 ft,; and the Main Ship Channel had in it 30 ft. for a width of from 500 to 800 ft., and 28 ft. for a width of 800 ft. through. He said the severe storm of Sept. 9, 1890, which caused a suspension of work for one week, seemed to have no effect upon the channel gained. At the present time there is a continuous channel 1,000 ft. wide and 30 ft. deep at mean low-water from the Narrows to the ocean, so that the largest steamships can enter and leave the port at any time. The total appropriations for this work, 1884-1890, amounted to $1,490,000.

Referring to original estimates, the plans for a 4-mile stone dike, including necessary dredging in the Main Ship Channel, which it was supposed the dike would not affect, called for a total expenditure of about $6,000,000. The first contract for dredging was given out at 54 cts. per cubic yard, and Major Gillespie, in 1885, figured the cost at 50 cts. for Gedney's Channel, and 40 cts. for the Main Ship Channel. But in 1886 the engineers estimated the cost at between 34 and 35 cts. per cubic yard. The actual cost, as stated by Mr. Edwards, was as follows: As the work was done under different contracts, varying in quantity and price, the aggregate must be taken. This was $1,285,682.94 paid for the removal of 4,875,079 cu. yds. (instead of the 4,300,000 cu. yds. originally estimated). The average actual cost is 26.4 cts. per cubic yard, or only 23.37 per cent. of the original estimated cost of the projected work. The average price in the Main Ship Channel, for dredging, was 25.26 cts. per yard, and 28.5 cts. in Gedney's Channel.

The material in Gedney's Channel, according to Major Gillespie's report of 1885, was gravel, coarse gray sand and shells for a depth of 2 ft., and well compacted. Under this was coarse sand, similar to that on the adjacent beach and shoals. In the Main Ship Channel there was a large percentage of mud, too fine to be caught in the bins, and the material generally was compact and difficult to raise with pumps. These conditions resulted, up to the report of Major McFarland in 1888, in the contractor lifting 1.73 cu. yds. of material for each cubic yard paid for, as much of it was so fine that it went overboard with the overflow and was generally carried by the cross-current beyond the walls of the channel, to the corresponding advantage of the Government and disadvantage to the contractor.

The various contracts made with the Joseph Edwards Dredging Co., and carried out by the dredges here described, were in amount and price as follows:

	Cubic yards.	
Gedney's Channel	1,369,777	at from 28.5 to 17c.
Main Ship Channel	2,930,086	at from 28.5 to 16 7-8c.
Total	4,299,858	Average....24.48c.

These contracts ranged in date from April, 1887, to August, 1890. The total amount removed by the several preceding contractors was 575,221 yds. from both channels, and the general average price paid was 40.53 cts. per cubic yard. A detailed history of these contracts is given by Mr. Edwards in his paper, which we omit.

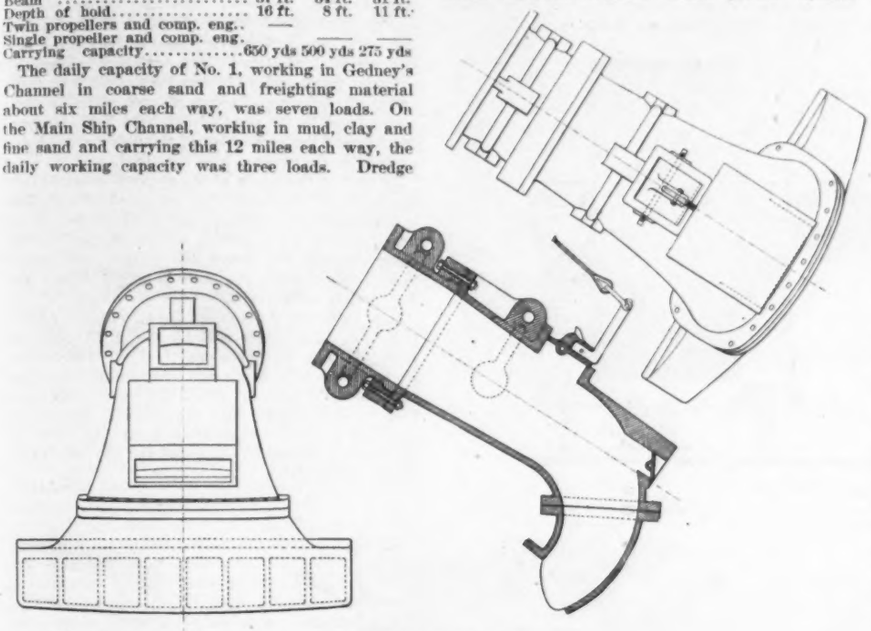
By the contracts with Mr. Edwards the material had to be raised from a depth of 24 to 35 ft. under water, and elevated to a total height of from 36 to 46 ft., according to state of tide and depth of channel. For each cubic yard of solid material thus handled there had to be raised many cubic yards of mixed mud, clay, sand and water. The system employed by Mr. Edwards was a hydraulic dredge operated by centrifugal pumps, specially adapted to the exposed character of the work, the depth of water, etc. The plant provided consisted of three sea-going dredging steamers, four large scows, four steam tugs for towing scows, one steam supply boat, one steam tender, and docks, repair shops, store-

houses, etc. The three dredging steamers had the following dimensions:

	No. 1.	No. 2.	No. 3.
Length	157 ft.	132 ft.	145 ft.
Beam	37 ft.	34 ft.	31 ft.
Depth of hold	16 ft.	8 ft.	11 ft.
Twin propellers and comp. eng.	—		
Single propeller and comp. eng.			
Carrying capacity	650 yds	500 yds	275 yds

The daily capacity of No. 1, working in Gedney's Channel in coarse sand and freighting material about six miles each way, was seven loads. On the Main Ship Channel, working in mud, clay and fine sand and carrying this 12 miles each way, the daily working capacity was three loads. Dredge No. 2 had a similar daily capacity of seven and three loads. Dredge No. 3 discharged into scows, and in working on the Main Ship Channel had a daily capacity of eight scow loads of 500 cu. yds. each. These scows were towed to the dumping ground by the tugs.

Each steam dredge was provided with two independently arranged pumping outfits, each having its separate centrifugal pump, engine and suction and discharge pipes. The suction pipes were on either side of the steamer and located about midships, and could be raised or lowered by suitable hoists. These suction pipes were from 15 to 18 ins. in diameter and about 60 ft. long. To render them flexible, during the pitching and rolling of the steamer, a 12-ft. section, a few feet from the bend, was made of rubber supported by a special hanging arrangement of chains, blocks and hoisting purchases, against the strain caused by the weight of the pipes and contained material. Tension chains protect against the longitudinal strain of the drags resting on the bottom.



DETAILS OF DRAG.

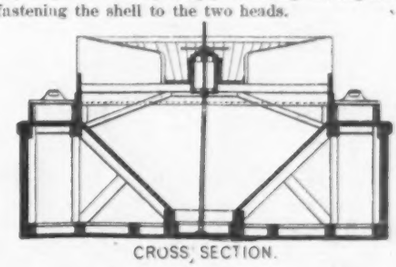
The steamers were constantly moving with the suction pipes, laying at an angle of about 30 to 40 degs. with the bottom. To keep the steamer on the line of work and supply the drags with work, she was kept constantly under steering headway. As soon as the sand bins were filled the suction pipes were hoisted and the steamer went under full headway to the dumping ground, the bin-gates were opened as the boat was turning, and the return passage then made to the work. This work had to be performed in an open bay exposed to the full sweep of the ocean; the dumping ground was at sea, requiring a round trip of 12 to 28 miles for the two channels; large ocean steamers passing in and out made it frequently necessary to shift the position of the dredge, and rough seas, fog, and sometimes running ice caused a suspension of the work for several days at a time.

Under these circumstances, the following statement of work performed by Dredge No. 1 in Gedney's Channel is interesting as giving the average for 28 1-2 working days in September and October, 1891:

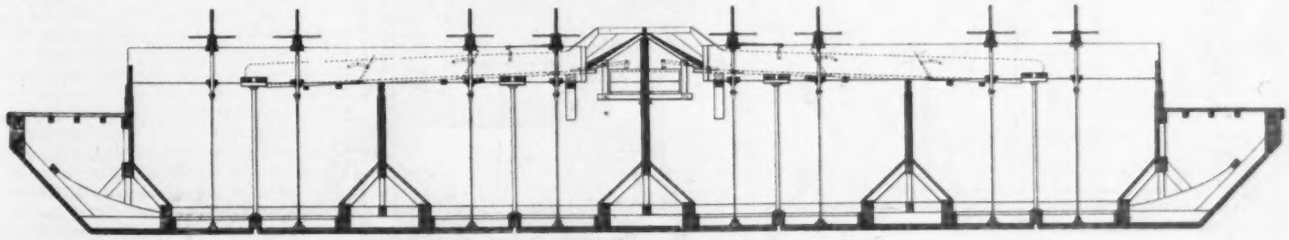
Average time pumping per load	48.6 m.
Average cubic yards per load	584.87 cu. yds.
Average time pumping per day	4 h. 58.4 m.
Average time on bar per day	5 h. 43.4 m.
Average time bar to dump	34 m.
Average time dumping	12.1 m.
Average time, dump to bar	25.7 m.
Average time, dump to anchor	66.6 m.
Average time, anchor to bar	51 m.
Average number of loads per day worked	6.73
Average cu. yds. per day worked	3,936.65 cu. yds.
Average rate per minute	12.03 cu. yds.
Time lost by repairs	2 h. 24 m.
Time lost by weather	32 h. 50 m.
Total time lost	35 h. 14 m.

(In a total of 458 working hours in 28 1-2 days.)

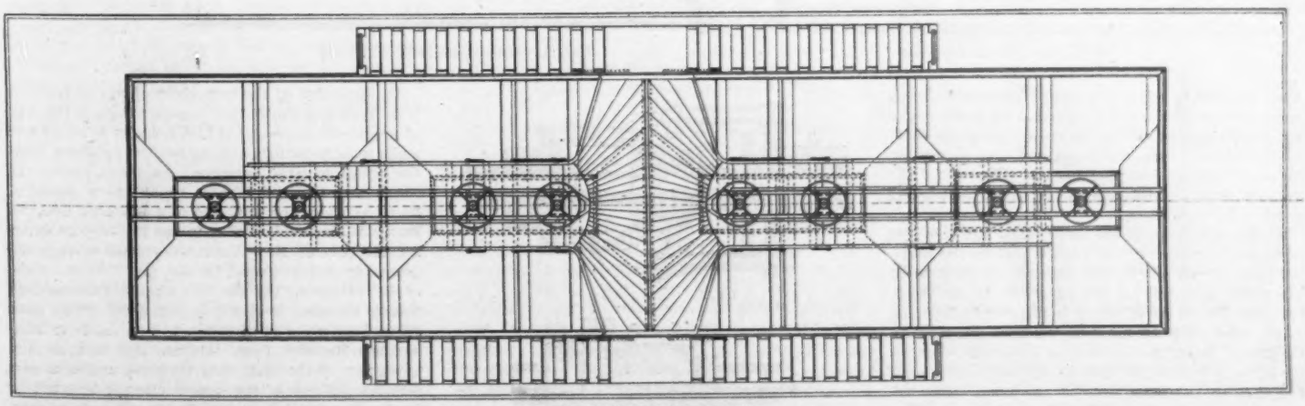
The special features of the pumps used on the dredging boats may be given as follows: To provide free ingress to the material to be pumped, the wings (MM) (fig. 3), opposite to the inlet current equal to the diameter of this inlet, are cut away in an ogee form, with the result that the inlet current is uninterrupted by the rotation of the wings until it reaches the central part of the pump. To enable the position of the outlet to be changed to any desired angle with the horizontal plane, independent of the suction, the shell or casing (PB) (fig. 3) is independent of the base and is held by the two heads which are bolted to the base plate. This shell can thus be rotated vertically and the outlet placed at any angle desired by simply removing the lug bolts fastening the shell to the two heads.



CROSS SECTION.



LONGITUDINAL SECTION.



PLAN OF DUMP SCOW.

To hold and adjust the rotating parts against displacement by the suction force and to keep the wings from coming in contact with the suction head, a special device has been patented, shown in detail in Fig. 4. The circular yoke (OO) is fastened by collar-bolts to the flange (D'D') of a specially

provided central projection on the front head of the pump. Surrounding the pump-shaft (H), where it passes through the yoke, is an externally threaded sleeve (T) which is screwed into the yoke. Upon the pump-end of this sleeve is a jam-nut (m'),and on

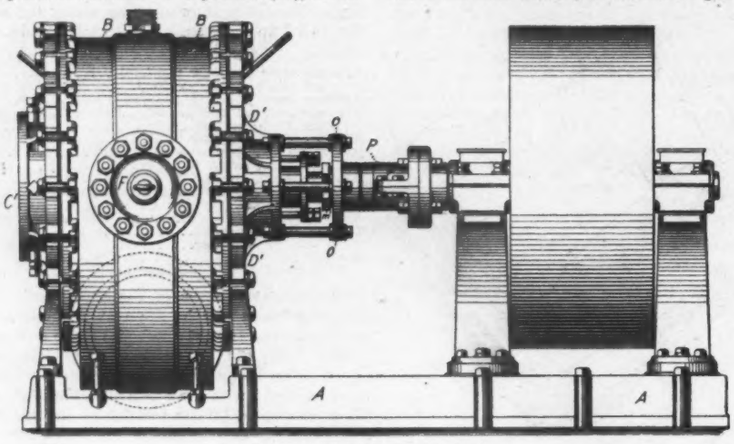


FIG. 1. GENERAL ELEVATION.

light and of wrought and easily bent metal, yet sufficiently strong for the work being done. These are fastened to the permanent wings, each with two bolts, one at each end, having their bolt holes slotted out to the ends thereof, as shown in fig. 5.

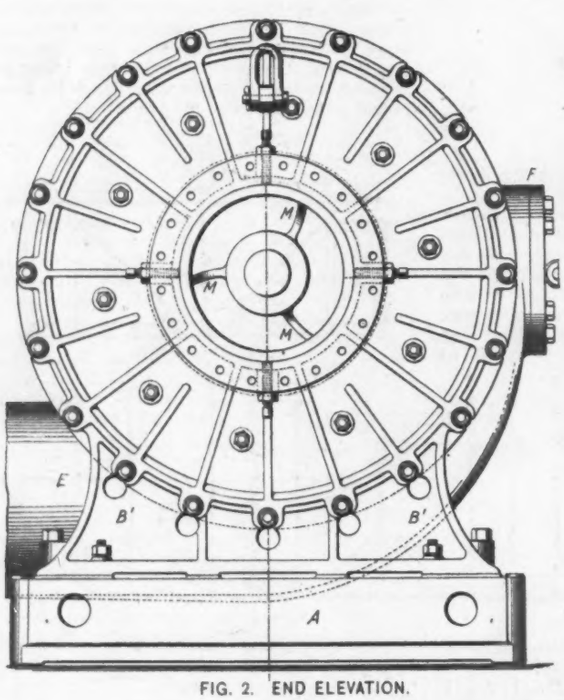


FIG. 2. END ELEVATION.

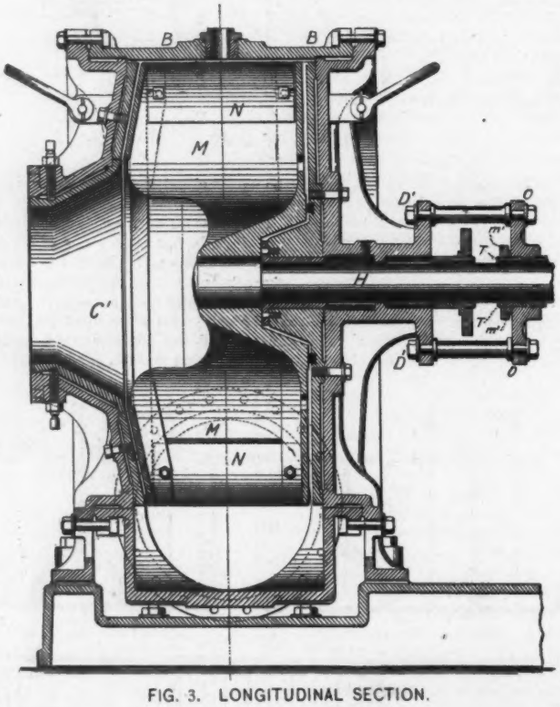


FIG. 3. LONGITUDINAL SECTION.

FIG .5.

the outer end is a heavy flange (m) with two loose, smooth-faced washers (ii). Outside of these last is the shaft coupling (P) which unites the pump-shaft to the driving shaft, the pump end of the coupling faced to work against the washers. The sleeve (T) does not come in contact with the shaft, there being a space between them.

By this arrangement the longitudinal strain on the pump-shaft, caused by the suction pull on the rotating parts of the pump, will, through the medium of the shaft, first fall on the pump-end of the shaft coupling (P), which of course is immovably fastened to the shaft, then on the loose washers (ii), then on the flange (m) of the adjustable sleeve (T), then on the circular yoke (OO), then on the collar-bolts (oo), and then on the front head of the pump. This arrangement of the threaded sleeve (T) also provides for longitudinally adjusting the rotating parts of the pump within its shell whenever required.

To prevent serious damage by breakage of more expensive parts of the pump, the permanent wings (MM) (fig. 3) instead of extending from the hub to the shell, extend about two-thirds of this distance. To these permanent wings are bolted what may be termed extension or false wings (N), made

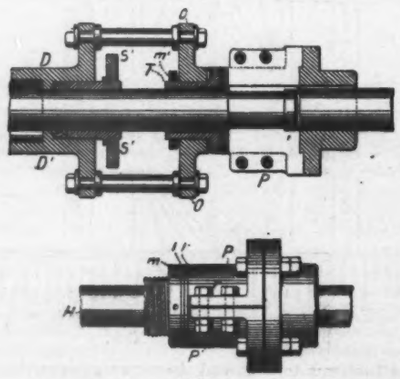


FIG. 4.

By this arrangement any unusual body encountered will be thrown by centrifugal force to the outer ends of the wings, and exert their violence against these false detachable wings, and bend and carry them away by drawing them from their bolt fastenings, and thereby prevent greater damage to more costly parts of the pump. These false wings are inexpensive and quickly replaced. Experience has demonstrated, however, that unyielding objects nearly equal in size to the diameter of the suction pipe often pass through the pump without doing any damage to it whatever. But unyielding objects of irregular form, such as broken bars of pig iron, fragments of anchors and pieces of anchor chains, etc., encountered in the channels of New York Harbor, necessitated the application of the detachable blades as and for the purpose here described.

To protect the heads of the pump from rapid cutting action of the sand, they are provided with less expensive internal facings; and to facilitate the examination of the condition of the interior of the pump, replace the detachable wings, and readily make other repairs, the shell is provided with the man hole (F), Figs. 1, 2.

This work was done under the direction of Lieut.-Col. Geo. L. Gillespie and Lieut.-Col. Walter McFarland, Corps of Engineers, U. S. A. Col. Gillespie made the original surveys and projected and recommended the plan by which this improvement has been so expeditiously and satisfactorily carried out at a cost to the Government of about 25 per cent. of the amount originally estimated for the only other project presented.

An inspection of the map given of the entrance to New York will show what has been done in the way of improvement and what also remains to be done to make a more perfect and convenient approach from the ocean to The Narrows. As there shown the Main Ship Channel is now opened to a depth of 30 ft. at mean low tide, and to a width of 1,000 ft. But it is also evident that to use it steamers entering the port of New York must make a very unnecessary and awkward detour, and turn an angle of 115 degrees. On the other hand the so-called Swash Channel, if similarly improved, would save about four miles in distance, is less liable to sedimentary deposits from Raritan Bay than is the lower part of the Main Ship Channel, and as to permanence surveys of the various existing channels as far back as 1835 show that the Swash is in as good condition as it was 56 years ago. The velocity of flow of water through the Swash is twice as great as in the Main Ship Channel on the Knolls, and its flow is nearly parallel with the channel axis, and will facilitate navigation as compared with the tidal cross currents in the other channel.

In commenting on the advantages of the Swash over the Main Ship Channel as a means of entering

the harbor, the author of the paper gives the following reasons for the selection of the latter for improvement by the government engineers: At the time the government decided to improve New York harbor, the permanency of dredging operations alone in channel making was yet in doubt, and dredging was commenced as a preliminary to diking, etc. Had it been a question of dredging alone it is altogether probable that the Swash Channel, as the more direct route, would have been selected for improvement. As to future improvement in the Swash, Mr. Edwards says that in view of increasing number of large ocean steamers entering this port, the saving in the items of extra fuel and time would in time aggregate a sufficient sum to pay the cost of opening up the Swash Channel to a width of 1,000 ft. and to a depth of 30 ft. at mean low water. This channel is now used by nearly all navigators that are not compelled to take the longer route by reason of the great draft of their vessels.

Electrically lighted buoys have been in use since November, 1888, along Gedney's channel. Three spar buoys, each carrying a 100 c. p. incandescent electric light upon its head, are moored on each side of the channel. The buoys are straight spars of juniper about 50 ft. long and a foot in diameter. Each is anchored to a 4,500 lb. cast-iron sinker, which can be easily moved with changes in the position of the channel. The lamp is enclosed in a heavy glass lantern, which is protected by an iron cage secured to the head of the pile and made to secure the greatest strength with the least obstruction to the light. Current is furnished to these buoys from a station on Sandy Hook, and is transmitted through a cable containing 21 copper wires made up in strands to form three separate conductors. Each conductor is insulated with three coatings of pure gutta-percha. Over this is laid a layer of tarred jute and the cable is then armored with a wrapping of 16 wires, No. 6, B. W. G. Over this armor is a layer of tarred hemp, and a second wire armor completes the cable.

At the power station all the plant is in duplicate to prevent stoppage by accidents. There are two vertical tubular boilers and two Armington and Sims high-speed engines. The electrical apparatus is of Edison manufacture. Current is also furnished from this station for the beacon on Sandy Hook.

The total cost of the plant, including a naphtha launch built for attending the buoys, was $19,530. The operating expenses average $400 per month. In the first two years of service of the plant the effiency was 93.61 per cent., these figures being based on the ratio of the number of lamp hours actually burned to the number of lamp hours which would have been burned if all the lamps had burned every night in the year. Most of the stoppages were due to injury to the cables caused by vessels catching them in their anchors, and often breaking them or cutting them to get loose. It is for this reason that the new cable, the construction of which is described above, has a double armor instead of a single one like the cable first used. Some trouble has also been experienced from ice freezing on to the buoys in severe cold weather and sinking them so low that the waves wash over the lantern. Even under these circumstances, however, the lamps continued to burn and could be plainly seen from Sandy Hook; 3 miles distant, whenever the head of the buoy was above water.

THE "GREER" SPIKE.

In different articles on track spikes we have referred to the fact that attempts to increase the holding power by jagging or twisting the spikes have been unsuccessful, such spikes showing less resistance to pulling than those of ordinary pattern. We have, however, pointed out the advantages to be gained by making the spikes with sharp points, clean, sharp edges and smooth surfaces, so as to cut and press aside the fibers of the wood instead of tearing them. In this way, more especially with soft wood ties, the fibers are cut as the spike is driven, and instead of being crushed and torn by a blunt edge and rough surfaces they are cleanly cut and then pushed back and compressed by the shank of the spike, against which they pack tightly, affording a strong resistance to the pulling of the spike.

We illustrate this week the "Greer" spike, which has been put on the market by Morris Sellers & Co., of Chicago, and which presents the advantages mentioned above. The spikes are of mild steel, cut from bars rolled to the required section. The regular size is 5 1-2 ins. long, 13-16 or 7-8 in. wide, and varying in thickness from 5-16 to 9-16 in. by the swelling of the sides, as shown in Fig. 1. The head is specially designed to insure straight driving, the blows coming upon the center of the head, and not upon the lip which holds the rail flange. The shape of the head also affords special facilities for drawing the spike with the ordinary claw bar, by using the rail base as the fulcrum, and the spike can thus be drawn easily and quickly without bending or breaking. The point is ground to a chisel edge, cutting the fiber as above mentioned, while owing to the comparative thinness of the shank it is claimed that the fibers are not forced back beyond their power of recovery when

Fig. 1. The Greer Spike.

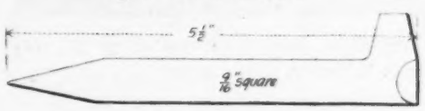


Fig. 2. English Square Spike.

the spike is drawn. The wood, therefore, tends to close the hole after the spike is drawn, and if the spike is redriven in the same place, the holding power is little lessened. The holding power is from 2,300 to 4,000 lbs. greater than that of the ordinary form of spike, 5 1-2 ins. long and 9-16 in. square, as shown by the following table. This is owing to the grip of the uninjured fibers of the tie upon the greater surface width of the spike. The increase of 50% in the width also tends to prevent the spreading of track, as well as the cutting of the spike under the head, which is generally caused by the narrowness of the spike, and by the spike not holding the rail firmly to the tie, but allowing the flange to wear the side of the spike. These advantages make the spike specially suitable for use on bridges and trestles, and at frogs and switches, as well as on ordinary track. The following table gives the averages of a number of tests, the two kinds of spikes having been driven in the same ties.

Fig. 3. Result of Lateral Pressure Against Base of Rails.

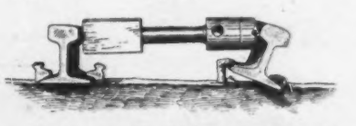


Fig. 4. Result of Lateral Pressure Against Head of Rails

	Average resistance of spikes.		
	Greer.	Ordin'y.	Excess Greer.
Cedar ties, by Morris Sellers & Co.	2,317	1,327	990
Cedar ties, by Chicago & Northwestern Ry	3,992	1,672	2,320
Oak ties, by Chicago & Northwestern Ry	8,372	6,252	2,120
Baltic pine, by English test	4,322	2,372	1,950
English elm, by English test	9,868	5,867	3,941

The English tests referred to in the table were made by Mr. Thomas Nash, at the Sheffield Testing Works, the ordinary spikes being of the pattern shown in Fig. 2. For fastening the chairs used in standard English railway construction, round spikes are used, driven into holes bored in the ties. The square or "dog" spikes are used for light track and for colonial railways. The Baltic pine is about equal in quality to American pine, while the English elm is not so good as American oak. The ties were 10 by 5 ins. section, and were not treated by any preservative process. In these tests the Greer spikes were 5 1-2 by 7-8 by 3-8 ins., and the English spikes 5 1-2 by 9-16 by 9-16 ins. Both kinds were 4 5-8 ins. long under the head to the point.

Fig. 3 shows the result of applying lateral pressure to the base of rails fastened by outside spikes of the Greer and ordinary patterns, and shows also the method of making the test. The ordinary spike 5 1-2 by 9-16 by 9-16 in. was bent back and lifted upward, pressing back into the wood in rising, while the Greer spike was unmoved. Fig. 4 shows the result of applying lateral pressure in a similar way to the heads of rails fastened by the two kinds of spikes. The inside ordinary spike was pulled up, allowing the rail to be canted over, while the Greer spikes held the rail firmly both inside and outside. These tests were made to show the action of the spike as a rail brace, owing to its increased width, and its consequent adaptability for use on curves. Similar results were obtained in the English tests above referred to.

Details of other tests on the holding power of spikes will be found in Engineering News, Sept. 26 and Dec. 5, 1891.

NATURAL GAS AND CRUDE OIL FOR FUEL AT THE DETROIT WATER-WORKS.

For some months natural gas has been used for fuel at the pumping station of the Detroit City Water-Works. Arrangements are now being made for substituting crude oil for fuel in place of natural gas. Through the courtesy of Mr. L. N. Case, Secretary of the Detroit Water Commissioners we are enabled to present some facts regarding the use of oil and gas at Detroit.

The regular rate for natural gas in Detroit has been 33 cts. per 1,000 cu. ft., less 8 cts., if paid on or before the 10th of the month, making a net rate of 25 cts. Gas has been furnished to the water-works, however, for what it would cost to do the same work with coal, the gas company receiving the benefit of all labor saved.

The gas bill at Detroit for the month of December would have been, at the ordinary rate, $3,092 The city paid on an estimate by Secretary Case an amount equal to the cost of pumping with coal, or $2,720. The quantity of gas consumed was 12,366,000 cu. ft., which made the rate paid very nearly 22 cts. per 1,000 cu. ft.

It must be stated that this cost of pumping is rather large, since hard coal is used, which on an average, in the house, $4.25 per ton. The objections to the use of soft coal have been so serious, Mr. Case states, as to prevent its use. The consumption of gas is, therefore, under the above contract, no more economical than coal, and while it is in some ways preferable, yet there are other features about it that are very objectionable.

Mr. Case states that after giving the subject of burning crude oil careful attention and ascertaining the experience of others, that he has arrived at the estimate given below, which he presented the Board. This led to a committee being appointed to investigate the matter and to make the necessary preparations for the use of crude oil for fuel. The figures are as follows:

Gallons of oil equal to one ton [hard] coal	168
Tons of coal consumed in 1890*	7,616
Cost of coal in shed	$31,763
7,616 tons of coal, equivalent in oil	1,279,488 galls.
Probable cost of 100 galls. of oil f. o. b. Detroit	$1.20
Total cost of oil equivalent to coal of 1890	$16,406
Saving of labor upon basis of 1890	$1,620
Outside estimate of carrying from cars to tank at works	$3,000
Total cost of oil	$17,787
Saving (as against $31,763 for coal, see above)	$13,976
Percentage of saving	44

The question of carrying the oil from the cars to the pumping works, a distance of about two miles, is considered a serious one, and plans are now being considered for accomplishing this at the least expense. The most favored plan is to erect a tank at the railway station and pipe to the pumping works by means of water pressure.

If we remember correctly, it was stated when the city first contracted for gas as fuel that it was to be delivered to the works by the gas company without cost to the city for piping and connections. The crude oil, we understand, will be furnished by the Standard Oil Co.

As we recently stated crude oil is also to be tried by the city of Minneapolis at the North Side pumping station. These experiments will be watched with interest, and the results, with comments, will be published in due time.

* To pump about 12,121 million gallons of water.

TWO MEDICINE BRIDGE, GREAT NORTHERN RAILWAY.

The accompanying illustrations, for which we are indebted to Mr. E. H. Beckler, Chief Engineer of the Pacific extension of the St. Paul, Minneapolis & Manitoba Ry., give a general view and details of the great Two Medicine bridge on that railway. The structure, which ranks among the very highest timber trestles ever erected, is 751 ft. long and 211 ft. from rail to water. It consists of one span of 120 ft., four spans of 40 ft., and all the rest of 16 ft. The great Portage bridge, now no more, was only 234 ft. above water, and stood on 31-ft. piers.

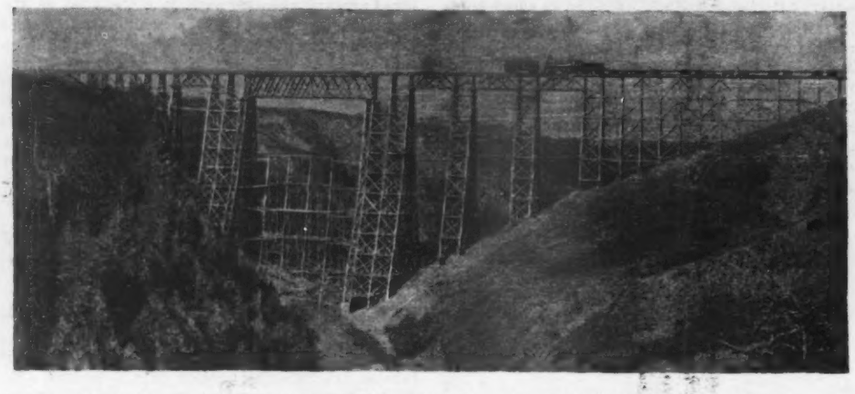


FIG. 1. VIEW OF TWO MEDICINE BRIDGE, 211 FT. HIGH; PACIFIC EXTENSION OF ST. PAUL MINNEAPOLIS & MANITOBA RY.; E. H. Beckler, Chief Engineer.

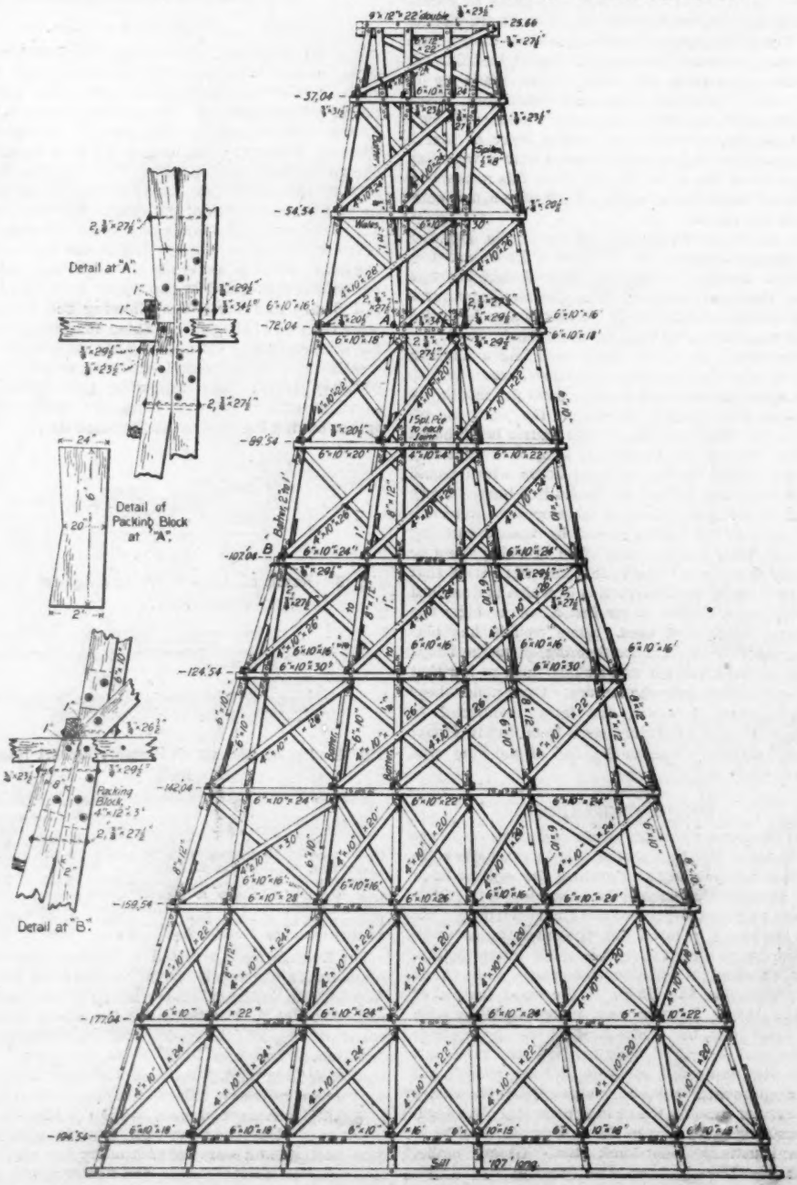
Fig. 1 shows a general view of the structure; Fig. 2, an elevation of one of the tower bents; Fig. 3, one of the other bents, and Fig. 4, a section of floor. There are not many special features requiring notice which are not apparent from the plans. The posts are made continuous from the foundation to the cap, packed at every story with a plank 4 ins. by 12 ins., 6 ft. long. The stories are made 17½ ft. in height so as to permit the use of 18 ft. lengths in posts, and also to avoid using too long pieces in the longitudinal and sway bracing. Good timber is not plenty in Montana in long lengths. The inside posts have a batter in order to afford a better system of sway bracing for the lower stories than could be had with plumb posts, and also to make better spacing on the foundations. Additional posts are inserted as the height increases. An additional batter post is placed on the outside when the height has reached such a point that it is needed on account of wind pressure. The assembling of the various parts is made in such a way that the trestle is easily raised piece by piece, and any piece of post, cap, wale, girder or brace can be removed without disturbing other parts of the bridge. The arrangement of short spans alternating with two trestle bents, as shown in Fig. 1, was found to be the most economical plan where the height exceeded 100 ft. For heights under 100 ft. trestle bents with 16 ft. spans are used. The foundations are cribs, solid rock and stone piers, and for the lighter bents, piling or mudsills.

One other feature needs mention, and that is, why a wooden bridge was built instead of an iron one. The reason was that the probable delay of tracklaying would not permit of waiting for an iron structure. The bridge contains about 750 M. ft. B. M. of timber.

It will be observed that the floor of this bridge is pretty solid, as it well might be for such a structure; 6 by 8 ties laid flat and spaced 12 ins. between centers or 4 ins. in the clear, inside guard rails and outside guard timbers, well notched down and bolted, make a tolerably safe floor.

WAUKESHA WATER FOR CHICAGO AND THE WORLD'S COLUMBIAN EXPOSITION.

The continued agitation as to the impurity of the water supply system of Chicago for several years, has resulted in the formation of at least a dozen local water companies to furnish spring and mineral waters to private consumers. The principal springs are located in Illinois, Wisconsin and Michigan, and the water from all of them, up to the present time, has been transported in wooden casks specially lined so as not to make the water taste. It is then put into cans and bottles holding from one quart to ten gallons, and delivered to customers by wagons. It is fair to infer that these enterprises are financial successes from the fact that the Waukesha Hygeia Spring Co. has been incorporated with a capital of $2,000,000 and has already begun work on a pipe line to convey water from Waukeska, Wis., to Chicago, 104 miles distant. A franchise has been granted by the city to lay pipes through specified streets, set hydrants at intervals of three or four blocks for supplying their wagons, and establish stations with attendants in charge. The same privilege has been secured from the World's Columbian Exposition, and it is proposed to have 300 booths, having five attendants each, scattered about the grounds. A $30,000 cooling plant will be erected at the entrance to the grounds, which will cool the water to a temperature of 35 degrees. The entire cost of the World's Fair plant is estimated at $300,000. Water will be conveyed by gravity through an 8 in. riveted pipe. There will be a fall of 480 ft. in the 104 miles. The pipe line will cross the Chicago River at Market St. and continue southward through the center of Franklin and Van Buren Sts. to the alley between State St .and Wabash Ave.; thence through the alley to 63d St. and the World's Fair grounds. It is proposed to have the whole system in operation within six months. The total estimated cost is $200,000. The officers are: Mr. J. K. Kerr, President, Waukeska, Wis.; J. E. McElroy, Secretary, Chicago; S. L. Conklin, Treasurer, Kansas City, Mo. Mr. J. W. Alvord is constructing, and Mr. A. V. Abbott, the consulting engineer.



F.G. 2. TOWER BENT.

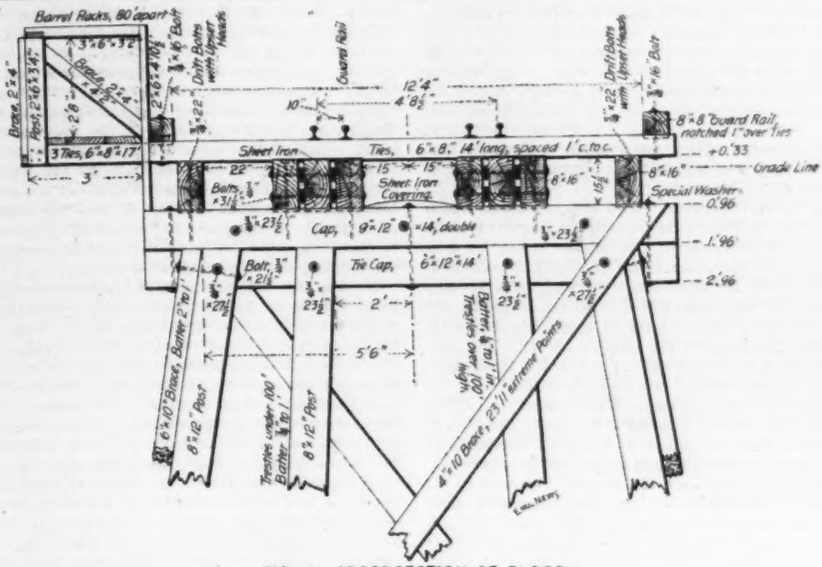


FIG. 4. CROSS-SECTION OF FLOOR.

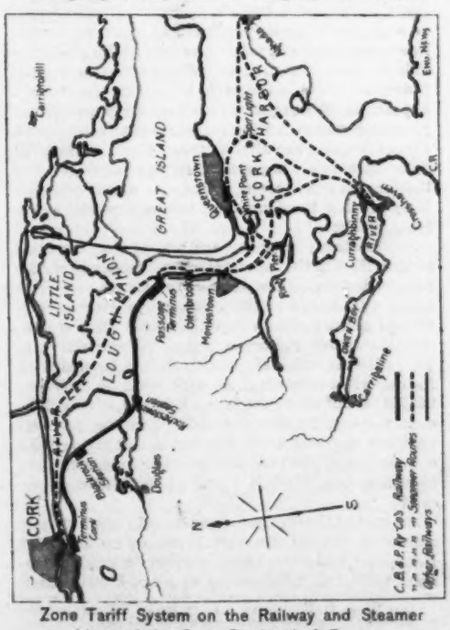
According to information furnished by Mr. J. J. O'Sullivan, General Manager, the result of the first month's working was in general satisfactory, although the weather was wet and cold, materially affecting the company's traffic. The number of passengers carried in May, 1891, was 2,005 more than in May, 1890, although the receipts were $510 less. It was estimated that if there had been one fine Sunday instead of four wet ones, the increase in passengers would have been at least 2,000 more, and the receipts equal to if not exceeding those of the previous May. The greater portion of the public appeared to appreciate the change, but some few persons who were affected to the extent of an increase of two or more cents in the short distances endeavored to start an agitation against the new system, but that soon died away and the new plan worked very well. The employees were particularly pleased at the simplicity of the system, entailing so much less clerical and other work.

In the company's report for the half year ending Dec. 31, 1891, it is stated that the adoption of the zone system of fares produced substantial results on distances under 8 miles, the number of passengers having increased by 17,075, and the receipts by $212.50. On distances above 8 miles, although there was an increase of 11,751 passengers, the receipts had largely decreased. This decrease in receipts for the long distances is due to the almost total absence of fine weather after July, thereby preventing the development of the usual summer excursion traffic to the seaside. Better results are hoped for during the next season.

The company's railway is 6 1-2 miles long, and its equipment consists of 3 locomotives, 7 first-class cars, 7 third-class and break cars, 2 covered freight cars and 2 ballast cars. The company also own 2 highway vehicles, 2 horses and 6 steamers, the latter ranging from 93 tons and 50 HP. to 130 tons and 80 HP. The traffic, it will be seen, is local and suburban, with summer excursions to the seaside resorts in the harbor, and excursion trips down the harbor.

THE ZONE SYSTEM OF FARES IN IRELAND.

The Cork, Blackrock & Passage Railway Co., of Ireland, adopted in May, 1891, the zone system of fares, as noted in our issue of May 9, 1891. The company has a suburban railway 6 1-2 miles long from Cork to Blackrock and Passage, and has steamer routes from Cork to Queenstown, 10 miles Aghada, 14 1-2 miles and Crosshaven, 15 miles, the boats touching at other points in the harbor. The railway and steamer services are shown on the accompanying map. Zone No. 1 is between Cork and Passage and intermediate stations. Zone No. 2 is between Passage, Queenstown, Aghada, Crosshaven and intermediate stations. The fares for single trips on each zone are 10 cts. for first or second class, and 6 cts. for third class. Through tickets covering both zones are sold at 20 cts. and 12 cts. respectively, and return tickets, available for the day of issue only, are issued at double the above rates. In adopting this system the company claimed that



Zone Tariff System on the Railway and Steamer Lines of the Cork, Blackrock, & Passage Railway Co., Ireland.

it would enable it to deal more satisfactorily with the great rush of summer traffic, as only eight sorts of tickets would be required, instead of the 150 different sorts of tickets formerly issued at the Cork station, while the new scale of fares was also 30 per cent. lower than the former scale.

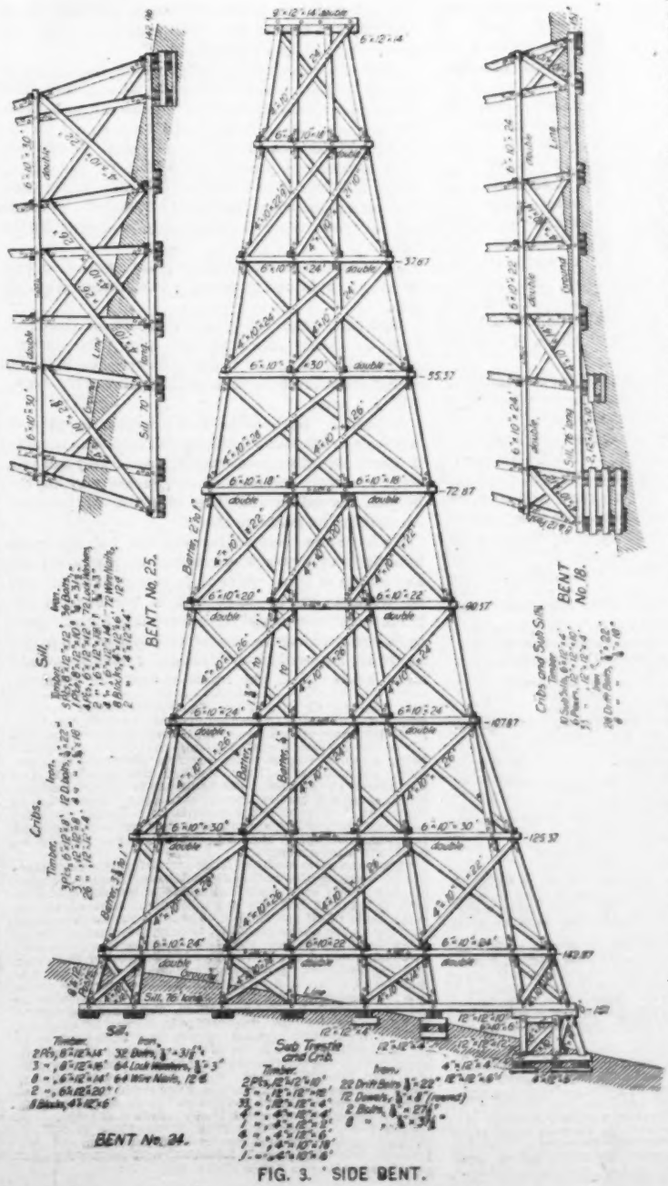


FIG. 3. SIDE BENT.

A novel method of thawing frozen earth for making street excavations was described by H. H. Kelley, Superintendent of the Waltham, Mass., Gas Works, in a paper read before the New England Association of Gas Engineers. Stone lime is spread several inches deep over the place where it is desired to excavate, and is thoroughly wetted and covered with straw. A piece of canvas or tarpaulin is spread over the heap, and it is left for 12 hours, more or less. In two cases in which Mr. Kelly has tried this method recently frost 18 ins. to 26 ins. was removed from the ground. In ordinary cases the expense of the lime would be too great to permit this plan to be adopted, but gas companies can use the lime afterward in their purifiers.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING.*

XIV.

COST OF OPERATING.

It is noticeable that the three systems of lighting in question all use an illuminant derived by distillation from the same substance, crude petroleum. The Pintsch oil gas system takes this crude oil and subjects it in bulk to a destructive distillation, by which it is nearly all converted into fixed gas of very high illuminating power†, having the further valuable property that this gas possesses few components which are readily liquefied by pressure, as does coal gas, so that the oil gas can, while the coal gas cannot, be compressed to 10 or 12 atmospheres without serious loss of illuminating power. When compressed to 10 atmospheres coal gas loses about 50% of its illuminating power, by liquefaction of certain of its elements; oil gas loses only 7.4%. (Eng. News, Aug. 22, 1891, p. 170).

To produce the other two illuminants the crude petroleum is subjected to a "fractional distillation" process by which several different illuminants are produced (Eng. News, April 18, 1891), the two most abundant being ordinary household kerosene (about 70% of the whole‡) and the various naphthas, benzines and heavier gasolines (16.3% of the whole). The parts lighter than the ordinary gasoline (0.7% only of the whole) constitute the light gasoline of 88° Beaumé boiling at 110° F., which is required for carbureters.§ On the other hand, the products heavier than household kerosene consist of "mineral sperm oil" (about 10% of the whole) of 300° F. fire test and boiling at 425° F., which is (supposed to be) used for car lamps, and about 5% of lubricating oil, paraffine wax and solid residuum.

Looking at the problem of comparative cost abstractly, therefore, to get an idea of permanent tendencies rather than momentary market conditions, it will be seen that the same very cheap illuminant, crude petroleum (worth 2 to 6 cts. per gallon) furnishes an extremely small quantity (7 bbls. in 1,000) of light gasoline suitable for carbureters, a quantity 14 times larger (100 bbls. in 1,000) of burning oil suitable for car lamps, and is all convertible into oil gas for compressed gas lighting. With the present mean annual product of 30,000,000 bbls. of crude petroleum, only 189,000 bbls. of 88° gasoline can be produced, and 2,700,000 bbls. of mineral sperm.

Mineral sperm being chiefly used for car lighting, and a few like uses where a high degree of safety is required, the supply may be considered equal to all probable demands, as also, of course, the supply of crude petroleum for gas making. The 88° gasoline, however, is what may be called a "fancy" product, suitable only for certain special uses, and a mere waste product if not applied to those uses, as was for many years the case; but liable to rise in price as its use extends, since the supply is strictly limited, especially as it is of so volatile a nature that from 15% to 20% must be allowed as wastage, between its distillation and its final use.*

Allowing the entire passenger stock of the country to average three hours per day of car lighting (1½ hours in summer, 4½ hours in winter) and the entire passenger stock of the United States and Canada to consist of 40,000 cars, we have the following estimates of the total quantity of illuminant required per year to light this equipment by either of these three systems:

1. Mineral Sperm Oil:—The Belgian lamp, which gave the best test in respect to consumption of oil per candle power hour, averaged as nearly as may be 1¾ oz. per lamp hour, or 1¾ × 12 × 3 = 63 oz. = 0.576 gallon for three hours' burning of a 12-lamp car.† Calling this in round numbers 0.6 gallon per car day (= 4.8 gallons for 24 hours burning of 12 lamps) this requires 219 gallons, or 5.215 bbls., per year per car, or 208,600 bbls. per year for 40,000 cars, the "visible supply" being 2,700,000 bbls.

2. Compressed Oil Gas:—"A fairly good yield of the gas, which can be obtained in every day practice, is 70 to 85 cu. ft. per gallon of crude oil" according to one statement based upon long English experience; according to another statement 70 to 90 cu. ft. is obtained in England. American experience runs lower, however, varying between 45 and 70 cu. ft. Full details on this point will be found in Engineering News, Aug. 22, 1891, pp. 170-71, from which it will be clear that about 60 cu. ft. of gas from each gallon, or 2,520 cu. ft. per bbl. of crude oil, is a fair average of good American practice. The Erie works, one of the oldest in the country, is now regularly realizing about 70 cu. ft. per gallon.

Each of the five 4-flame lamps which have been assigned to each car above, will burn when giving their maximum light 2.75 cu. ft. each per hour, or 13.75 cu. ft. per hour in all, equal to 41.25 cu. ft. per car per day, or 15,056.25 cu. ft. per car per year. To produce this quantity requires, at 2,520 cu. ft. per bbl. of oil, a little less than 6 bbls. of oil. For 40,000 cars, this means the consumption of 240,000 bbls. of crude oil per year, the "visible supply" being 3C,000,000 bbls.

3. Frost Carbureters:—This plant works in two ways, as explained in detail in our issue of Aug. 15, 1891:

Method 1. According to its theory of construction, by merely charging air with such amount of gasoline vapor as it can take up when both air and gasoline are below the boiling point of the latter (110° F.), and:

Method 2. By heating the gasoline, in part or whole, to or above its boiling point, and thus turning it gradually into steam, which may or may not mix with a certain amount of air on its way to the burner, according to the amount of pressure created by the gasoline steam.

We have no experimental evidence that the gasoline plant ever works according to Method 1 for any length of time. It is quite certain that it does not work so, but by Method 2, in the form of the plant which was supplied and erected for our tests by the manufacturers, and which has been and (so far as we are advised) is now almost exclusively used on all roads using the plant except the Pennsylvania. Indeed this form was in use for a time on quite a number of cars on the latter road, until the attention of its officers was attracted to its real nature. It is certain that the Pennsylvania form of the plant will not direct nearly so much heat around the carbureter as that used on other roads, and remembering also the evidence of the photometric tests, which show that much less light is given off by the Pennsylvania plant than by the newer form (compare Figs 7, 8, and Fig 6, Eng. News Dec. 19, 1891), we judge that the Pennsylvania plant as originally devised and as now exclusively used on that road heats but little of the gasoline above the boiling point, or perhaps none at all.

We can only consider accurately, however, the plant which we have experimentally tested and which is still in most general use, giving it credit for the extra light obtained, and extra consumption of gasoline. For comparative purposes as indicating what might possibly be proven for the plant if tests were made under Method 1, in which all boiling of the gasoline was prevented, we may assume that with only half the consumption of gasoline half the candle power might be shown. This is making a favorable assumption for the plant, however, as mixing half as much gasoline with a given quantity of air would more than halve the photometric power of the gas. Under Method 1 only 40% of gasoline by weight, at most, can be taken up by air (Eng. News, April 18, 1891, p. 608). Under Method 2 the gasoline used averaged 174% of the weight of the air used (Eng. News, April 25, 1891, p. 392) in the tests from which we derive our photometric records; *i. e.*, 1.92 gallons of oil (166 oz.) burned for 41 hours and was mixed with 72 cu. ft. (88 oz.) of air in that time.

At this latter rate the five lamps assumed for each car would burn 9.6 gallons in 41 hours, to which 15% should be added for wastage, making 11 gallons in 41 hours. In a year the lamps will burn 365 × 3 = 1,095 hours, whence 293.7 gallons, or 7 bbls. of gasoline per year will be required to light one car. For 40,000 cars this becomes 280,000 bbls., the "visible supply" being 189,000 bbls. If we assume, as above, that under Method 1 half this consumption will suffice for half as much light, obtained without boiling the gasoline, we still need 140,000 bbls. per year, or nearly all the present visible supply, assuming it to be all used for this purpose.

This supply is, on the one hand, capable of large increase (perhaps to double or more its present volume) as demand increases, and, on the other hand, is even now heavily encroached upon to supply fixed gas plants and other demands of the arts. The balance must be struck according to one's individual judgment, all that is certain being that the supply appears to be unequal to any very large increase of present demands, without increase of price. To some extent increase has already taken place. When the first experiments in gasoline car lighting began the lighter gasolines were almost a waste product. They are now the dearest of the commercial petroleum products.*

Summarizing the above, and adding from our issue of Dec. 19, 1891, the photometric efficiency in candle powers determined for the several plants, we have found that to light 40,000 cars for one year by each of the above methods requires 208,000 bbls. of mineral sperm oil for lamps, giving 273 circular c. p. per car (from which about 20% should be deducted for imperfect trimming of wick, etc., in service); 240,000 bbls of crude oil for making gas, giving 202½ c. p. per car, 280,000 bbls of 88° gasoline for carbureters operated under Method 2, and giving 395½ c. p. per car, 140,000 bbls of 88° gasoline for carbureters operated under Method 1 and giving 197.8 c. p. per car.†

The cost of these illuminants we take at 9.2 cts. per gallon for mineral sperm oil, 15 cts. per gallon for 88° B. gasoline, and about 4 cts. per gallon for crude petroleum, the latter, however, being a figure which does

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*The previous articles of this series have been as follows beginning in 1891:

I.—April 18, Introductory; nature of illuminants.
II.—April 25, Photometric instruments; burning tests.
III.—May 2, Frost carbureter plant; descriptive.
IV.—May 9, do.; the carbureter.
V.—May 16, do.; tests of strength of carbureter.
VI.—May 23, do.; charging carbureters, etc.
VII.—Aug. 15, do.; tests of functional action.
VIII.—Aug. 22.—Pintsch compressed gas; gas making.
VIII.—Aug. 29, do.; storing and distribution.
IX.—Sept. 5, do.; plant on car.
X.—Sept. 19, Oil burning lamps.
X.—Sept. 26, do.; oil tests, etc.
XI.—Oct. 10, do.; construction of lamps.
XI.—Oct. 17, do.; additional notes.
XII.—Nov. 14, Electric lighting; storage batteries.
XII.—Nov. 21, do.; English practice.
XII.—Dec. 5, do.; American practice.
XIII.—Dec. 19, Photometric tests and records.
XIV.—March 12, 1892, Comparative first cost.

[A republication in book form of this entire series of articles will be issued on or before May 1; price $1, post paid. Prior to April 15 notes of typographical or other corrections in any of these articles will be welcome, and receive attention.]

† The candle power of gas, unless otherwise stated, is always understood to be that of an Argand burner, burning 5 cu. ft. per hour. Ordinary city gas runs from 16 c. p. to (rarely) 20 c. p. or more; i. e., from 4 to 5 c. p. hours per cubic foot of gas. Oil gas, on the other hand, runs up to 60 or 80 c. p. or more i. e., to 12 to 16 c. p. hours per cubic foot of gas, being from 3 to 5 or more times as effective as coal gas.

‡ The Treasury Department has carried for many years at the foot of its petroleum statistical reports a statement that good authorities estimate that 100 gallons of crude petroleum will furnish 70 gallons of illuminating oil, 12 gallons of the various naphthas and gasolines, 3 gallons of lubricating oil and 9 gallons of residuum.

§ We neglect in this summary the chemical curiosity rhigoline, boiling at 65° F., which may be obtained in insignificant quantities by careful manipulation of the lighter distillates, as may also, in fact, still lighter distillates boiling at 1° and 38° F., by sufficiently delicate chemical processes. (See Eng. News, April 18, 1891.)

*A Baltimore oil refiner stated to us in regard to the supply of the various naphthas, that the crude oil, before being supplied to customers for fuel purposes, was put into a still and the naphtha distilled and collected. For this reason the supply of the naphthas is much increased and it must still further increase with the consumption of "Lima oil." This oil is being used very largely for fuel purposes now, and the production is as yet unlimited and increasing so rapidly that the pipe lines are said to be unable to meet orders.

This Lima oil is used but little as yet for the manufacture of burning oils, as it is difficult to refine and contains comparatively only a small quantity of burning oils. For this reason it is not (we are informed) included in the statements of oil production. This fact has an important bearing on the above estimate, though it is impossible to allow for it accurately, any more than for the large and increasing use of the lighter gasolines for other than car lighting purposes. Inquiry at the main offices of the Standard Oil Co., in New York, shows, however, that while the production of naphtha is now very great, gasoline is produced only in limited quantities. For the past six years there has been no great fluctuation in price of 88° gasoline, and it can now be bought in bulk in New York at 13 to 14 cts. against about 11 cts. for 86° gasoline and proportionately less for the benzines and naphthas. The higher officials state their belief that if the demand warranted it the production of the lighter gasolines could be greatly increased, perhaps enough to light all the passenger cars in the continent without much if any increase of price.

† Erratum. Under Fig. 1 of our issue of Dec. 19, 1891, p. 580, and again in the headings to the first column of Table I. on the following page, "7.0 oz." should read "3.5 oz." as in the heading to Table III., p. 596.

* Mr. W. H. D. Penniman writes us in regard to this paragraph: "It was a waste product at the refineries, but not in the market. In my experience in the last three or four years it has gone down in price, and we are now paying 9¾ cts. for it, delivered as we please."

† Mr. Geo. Gibbs writes us in regard to amount of light "I think your figures for the Frost system too high for average running. I find all forms of their lamps give very irregular results, depending upon condition of lamps and charge in carbureters." While this may be true in some degree, however, we do not feel justified in making any deduction from our photographic records for the carbureters, as we do for the oil lamps, where its propriety is indisputable.

not directly concern us, as it is included in the cost of the gas per M. cu. ft., which latter we have yet to determine.*

In our issues of Aug. 22, 29, 1891, we gave such full details as to the cost of manufacturing the gas at 13 different works, that we will now merely summarize and compare the final aggregates of those details. It is to be remembered that we have already allowed 15% on the first cost of the plant, or $15 per car per year for interest and depreciation of the fixed plant only, which latter items we do not need to consider again as part of the cost of producing gas. The total yearly consumption of gas per car being about 15,056 cu. ft., as above determined, this allowance of $15 is $1 per M. cu. ft. for interest and depreciation; the allowances made for these items in the statements published Aug. 22, 29, 1891, having been 72½, 56, 27, 20 and 28 cts. respectively, or all much less than we allow.

The cost for oil, fuel, labor, compressing, running repairs to plants and delivery in car receivers was thus reported in the successive statements of the issues referred to:

	Cost per M. ft.
Hunter's Inst. C. E. paper (Eng. News, April 13, 1889)	$1.58
Ayres' Inst. C. E. paper (read April 10, 1888)	1.32 to 3.84
Mean experience of six English railway systems	2.27½
One American works, producing 3,000 M. ft. per year (but obtaining only 46 cu. ft. per gallon of oil)	3.65
Another do. in same city, producing 4,000 M. ft. per year	1.83
N. Y. C. & H. R. R. R. plant, operated by Pintsch Co. and producing 9,000 M. ft. per year (including tankage of gas to Grand Central Station)	2.35
Erie plant at Jersey City, producing 6,500 M. ft. per year	1st 6 mos. 1.78; 2d 6 mos. 1.81

From this the assumption seems to us warranted that $2.20 per M. cu. ft. represents a fair general average of the cost of the gas in the tanks, including a certain amount of transportation in tank cars. On many favorably situated roads the cost may fall considerably below this, down to perhaps $1.75 per M. ft.; on others, unfavorably situated as to the supply of coal and oil and amount produced, the cost may rise to $4 or over for a time. When the gas is purchased in small quantities the usual price is $5, which either includes a good-sized profit or the loss from running new works below their proper capacity.†

The varying cost of the crude oil alone makes a considerable difference in the cost of the gas. It can, of course, be obtained most cheaply when a pipe line is accessible. With crude oil costing per gallon:

2 cts. 3 cts. 4 cts. 5 cts. 6 cts.

the cost for oil only of gas per M. cu. ft. of gas, at 60 cu. ft. of gas per gallon of oil, will be:

33 cts. 55 cts. 67 cts. 83 cts. $1.00

The actual reported cost of the oil only per M. cu. ft. of gas varies in the American works from 33 cts. to $1.20.

We can now prepare the following summary of the daily cost of illuminant per car by the various systems. For the visual units we take the mean shown by Figs. 10 and 11, p. 597, issue of Dec. 19, 1891:

	Consumpti'n per day of 3 hours.	Cost per gallon.	Cost per day of 3 h'r's.	Circular candle powr	Visual units
	galls.	cts.	cts.	c. p.	
Car lighted with mineral sperm oil	0.6	9.2	5.52	218.*	37.9
	cu. ft.	per cu. ft.			
Pintsch comp. gas	41.25	0.22	9.075	202.5	37.5
Frost system:					
1. Gasoline and air	galls. 0.4	cts. 15.0	6.00	197 8	39.1
2. Gasoline steam	0.8	15.0	12.00	395.5	78.3

* 273 c. p. less 20% or 55 c. p. = 218 c. p.

*Some further information as to cost of Pintsch compressed gas is given in the discussion of a very recent paper on "Railway Train Lighting," (chiefly referring to electric lighting) by Mr. Wm. Langdon [Proc. Inst. C. E., vol. CVL., 1890-91. p. 154] Mr. J. P. Rickman (Gt. No. Ry.) stated that on the Northeastern Ry. the cost of oil gas from works supplying 600 coaches [perhaps equivalent in demand for light to 100 of our cars.—Ed.] was 8s. 6d. ($2.05) per M. cu. ft. His own company supplied the North British at $2 per M cu. ft., out of which "they made just enough to pay their way." The expense of filling "meant a few laborers and porters at $5 per week, so that the cost was a mere bagatelle."

† There are considerable variations in the price of oil and gasoline, according to location and the circumstances. Oil ranges in price from 7 cts. to (for small lots) 15 cts. Gasoline of 88° B. can be and is bought for delivery at points near refineries as low as 9¾ cts., as shown by a previous note. We consider the effect of these differences below, but regard the prices given as the fairest general averages. The Railway Lighting & Manufacturing Co. (Frost system) itself uses 15 cts. per gallon in its circulars for estimating the cost of lighting by its system; but Mr. W. B. D. Penniman writes us that he is quite certain that it can be bought for 11 cts. by any large consumer.

* Mr. Geo. Gibbs, in his paper before referred to, allows 3.18, 1.65 and 3.36 cts. per day of three hours for care of oil, gas and carbureters respectively, instead of 5, 2 and 3 cts. respectively which we have adopted. He states that this is in each case based upon the actual experience of his road, which as respects oil lamps was for a stock of 466 passenger cars, but as respects the other two was for so small a number of cars as to be open to some suspicion, though based upon exact records. His estimate for oil lamps includes the storekeepers' charges for burners, chimneys, shades and small supplies, while the attendance charges were carefully deducted from the pay rolls, with allowance for time of men partially employed so far as possible. These figures seemed so very low, however, that we have slightly increased them as above, and we believe them still to be too low. Our guess would be that 10, 4 and 6 cts. would come nearer to the truth, all items considered. Some official German estimates of the cost of cleaning lamps show that oil lamps and compressed gas compare as to this item in the ratio of $3.30 to 85 cts., and in all items, per lamp hour, in the ratio of 0.70 cts. to 0.15 or 0.19 cts. A variety of other German estimates of this kind which we have examined show about this ratio. One shows the yearly cost of attending a gas lamp to be only 36½ cts., against $4.02 for oil lamps. The conditions of service are so different in Germany that direct use of these statistics for estimating purposes is difficult, but relatively they should be about fair.

It will be seen from the last column above that all three of these plants provide a very brilliant light. The "visual unit," as defined in our issue of Dec. 19, 1891, is one effective candle power at a distance of 4.5 ft. sending rays perpendicularly upon a surface at an angle of 45° with the horizontal. With some 39 candles burning at this distance, as defined, the passenger would have all the light which he could reasonably require for reading the finest print.

There remains but a single element to be determined before we can make a final summary of the comparative cost of lighting cars by oil, oil gas and gasoline gas, viz., the cost for attendance and minor supplies, including chimneys, shades and globes, new burners when necessary, and cleaning, filling and adjusting lamps. It is in the nature of things all but impossible to make an accurate estimate of this item for any system of lighting on any road; but as an average between many different estimates we believe the following to be substantially accurate, erring, if at all, in favor of oil lamps and (in much less degree) carbureters, by estimating their cost for this item too low.*

Cost of cleaning, attendance, glass breakages, small repairs, etc.

	Per year.	Per day.
Oil, lamps, 12 per car	$18.25	5 cts.
Pintsch gas, 5 lamps per car	7.30	2 "
Frost carbureters, 5 lamps per car	10.95	3 "

There is still another expense connected with the use of oil lamps, that of injury from spilled oil for which some allowance should be made, though we do not make any because it is impossible to estimate it exactly. It appears from an abstract of "Accidents in the Railway Mail Service," published in our issue of Jan. 30, 1892, that 2% yearly (1.97) of the postal cars in service have oil spilled from lamps as an effect of train accidents to a sufficient extent to damage the mails more or less. The instances in which oil is thus spilled from carelessness or structural defects, without any train accident, might easily be still more numerous. An allowance of $10 per car per year for this cause might not be unreasonable. In sleeping, parlor and other carpeted cars the loss from this cause is generally stated at a much higher figure.

We are now prepared to make the following summary of the TOTAL YEARLY COST OF LIGHTING A CAR, including all items of every nature and kind whatsoever except that of injuries from spilling oil. We subjoin to our table a rearrangement in the same form of the estimate of Mr. Geo. Gibbs, Mechanical Engineer, Chicago, Milwaukee & St. Paul Ry., in order to facilitate comparison. We consider his estimate far too low for oil lamps, and somewhat too high for Frost carbureters.*

* The following estimate was prepared some years ago for the Baltimore & Ohio road. Several important conditions have changed since then, and for that and other reasons it is not now considered accurate in detail, but we have requested permission to give it for completeness, and as an entirely independent estimate.

SUMMARY OF ESTIMATED AVERAGE TOTAL COST OF LIGHTING A CAR ONE YEAR, THREE HOURS PER DAY.

Interest, Depreciation and All Other Items Included, except injuries from spilling oil.

System of Lighting.	First cost of plant per car.	Int. and depreciation. Per ct.	Int. and depreciation. Amt.	Fuel supply. Per day.	Fuel supply. Per y'r	Cleaning and other supplies. Per d'y	Cleaning and other supplies. Per y'r	Total yearly cost.	Amt. of light. In candle powers.	Amt. of light. In visual units.	Hours' light betw'n charging.
				cts.		cts.					
Mineral sperm oil lamps.	$175	14	$24.50	5.52	$20.15	5.0	$18.25	$62.90	218	37.9	15
Pintsch gas	313	11	34.43	9.075	33.12	2.0	7.30	90.85	203	37.5	18
	130	16	16.00								
Frost { 1. Gasoline vapor	522	13	67.86	6.00	21.90	3.0	10.95	100.71	198	39.1	80
" " steam				12.00	43.80	3.0	10.95	122.61	306	78.3	40

Arranging in the same form the estimate made by Mr. George Gibbs in his paper before referred to, we have the following table as the equivalent of his estimate. Mr. Gibbs also estimates separately for three different forms of oil lamps, the Moehring, Duplex and Acme, showing the best economy for the latter, owing chiefly to its using one powerful lamp in place of a two-lamp chandelier. As we did not test the Acme we cannot say whether or not the claims made for it are justified.

				cts.		cts.					
Moehring lamps	$167	10%	$16.70	5.0	$18.25	3.18	$11.61	$46.56	144	[Not estimated]	15
Pintsch gas	370	10%	64.30	6.15	22.45	1.65	6.02	92.77	160		34
	182	10%									
Frost carbureters	536	15%	80.40	10.44	38.11	3.36	12.26	130.77	168		43

The following is a comparative estimate which has been by the Railroad Lighting and Manufacturing Co., reduced to the same form as the above, so far as possible, by rearrangement and by doubling the number of oil lamps estimated for, so as to correspond throughout with our own estimate of 12 oil lamps, 5 Pintsch lamps and 5 Frost lamps:

Oil Lamps	$210	Not estimated.	12	[Fuel supply and attendance included together as maintenance.]	$43.80	[Not estimated.]	72	[Not estimated]	5
Pintsch gas	317		10		36.50		100		15
	100								
Frost carbureters	597.25		2½		9.12		250		100

If our own estimates be accepted as correct, the defects of this statement are (1 a material underestimate of the cost of maintaining the Frost light, while approximately accurate as to the other two; (2) a material underestimate of the light given by oil lamps and compressed gas, and (3 some errors in the last column.

	Oil.	Comp. gas.	Carb'ters.
No. of cars taken as a basis	100	100	100
Cost of permanent plant	None	$15,000	None
No. of lamps per car	3	3-6 flame	4 Excelsior
Average C. P. for 10 hours	78 c. p.	130 c. p.	104 c. p.
No. of burning hours bet. refillings	10 hours	25—49 hours	120 hours
Cost per car of plant on do.	$303	$228	$329	$368.76
" of operating per hour.	4 cts.	2 cts.	2 cts.	1½ cts.
Total cost of lighting 100 cars 100 hours	$400	$200	$200	$150
Total cost of equipping 100 cars	$20,300	$37,800	$47,400	$36,876
Taking 3 hours per night as an average burning, cost of lighting one car per year = 1,095 hours	$43.80	$21.90	$21.90	$16.42
If we add to this operating cost our assumed interest and depreciation allowances of	14%	11 and 10%	12%	
Or in money, per car	$28.42	$49.08	$60.19	$47.94
We have as the total cost per year for lighting one car one year	$72.22	$70.98	$82.09	$64.36

If these estimates were corrected to be on a basis of equal light, they would show oil to be the most expensive of the three and compressed gas the cheapest. If we assume that 50% of the above total cost varies directly with

Change the figures set forth in the large accompanying table as we may, and keep within the bounds of reason, the comparative result seems to come out much the same. The table above is in such form as to make it easy to study the effect of any change. The first cost cannot be materially modified. The depreciation allowances cannot rationally be modified more than 2 to 3% either way and such change would have little effect upon the comparison. The amount of light, and with it the consumption of oil or gas, cannot be decreased more than 25% and have sufficient light. About 150 c. p. per car is now considered essential, and 200 c. p. is necessary to give what is now considered first-rate lighting. The three systems run so close to 200 c. p. each, as above tabulated, that for all practical purposes they may be considered as giving equal light.

Attendance and small supplies is a more dubious and variable element. Mr. T. N. Ely, Gen. Supt. M. P. Penna. R. R., informs us that he has recently had occasion to make a very careful investigation of both systems, as to which it would be best for them to use, which fully convinces him, among other things, that the cost of care, cleaning, regulating and so forth of a compressed gas system would much exceed that of carbureters. We can not adopt this conclusion as generally applicable, but it is an opinion entitled to great weight. Adopting it tentatively, by transposing the estimates for this item, so as to make this item cost 50% more with compressed gas than with carbureters instead of vice versa, we have:

	Oil lamps.	Gas.	Carbureters.
Instead of the above totals	$62.90	$90.85 deduct 7.30 and add 10.95	$100.74 deduct 10.95 and add 7.30
Total, with attendance charges reversed	$62.90	$94.50	$97.06

If our estimates for cleaning and attendance err at all, in our judgment, they err in being all too small, rather than in their ratio to each other. Increasing them to 10, 4 and 6 cts. per day per car instead of half those figures,

We add to our estimate above	$18.25	$7.30	$10.95
Making the total	$81.15	$98.15	$111.66

Or, reversing the charge for the gas and carbureter systems, according to Mr. Ely's suggestion, we have:

$81.15	$105.45	$104.36

If we assume gasoline to cost 11 instead of 15 cts. per gallon, it will deduct $5.84 from the cost per year per car by that system. If we change the estimated price of gas either way from $2.20 per M. cu. ft. it will add or deduct about $1.50 per year for each 10 cts. per M. ft. of change from that figure.

With all these figures before him, the reader can take his choice or make new figures of his own. It is to be remembered, however, that the economy of the compressed gas system varies, far more than either of the other systems, with the number of cars equipped for it, and hence on its first introduction the compressed gas system labors under a disadvantage from which the other two are free. The above estimate is intended to exhibit the cost when all or nearly all the cars of a considerable road are using it, not when it is first applied to a few cars.

In the last noted feature of the above comparative estimate, morever, "Hours of light between charging," the Frost carbureter plant has a decided balance in its favor, and if there is really any important gain in operating convenience from this difference, some money value should be assigned to it. We make no such assignment because we are unable to perceive that the difference is of moment, when the comparative ease of charging is taken into account. Charging with compressed gas is a very simple, quick and (with ordinary care) safe operation. The Pennsylvania Railroad has always charged its passenger cars with coal gas, when required, while cars were in transit and stopping at the stations. Charging carbureters with gasoline is a much longer operation, and to avoid possible accidents from spilling gasoline it is required to be done by daylight, outside of station buildings, and while cars are out of service. The frequent fillings required for oil lamps, with its attendant dirt and smell, are undoubtedly one of the evils of that system of lighting, but as respects the two gas lighting systems, it seems to us that between coupling on a hose for a few moments at the end of each round trip, and going through the more elaborate process of charging carbureters every fourth or fifth trip, there is little to choose.

As for the cost of lighting cars by electricity, we gave such full details in our issue of Dec. 5, 1891, that we need not go over the ground again. It is as yet not a feasible system for general use, yet its cost is not so excessive as to be unreasonable for trains "de luxe," as they are called abroad.* Its first cost varies from $400 per car upward, according to the number of cars per train, and the average cost per c. p. hour of all the eight different records given, has been 0.081 cts. per c. p. hour. This has been for the most part on an all-night service, whereas we have assumed only 3 hours per day (4½ hours in winter; 1½ hours in summer) to be the average period of lighting for all the cars on any road. But this average is made up by some of the cars running all night, and others only in day time, so that for merely approximate comparative purposes we may take the above cost per candle power hour and multiply it by 3 (hours) × 365 (days) × 200 (average candle power per car heretofore assumed) giving $177.39 for the average cost per car per year of electrically lighting all cars, to which is to be added at least $40 per year (10%) for interest on first cost and depreciation, making $237.39 per car per year in all, as against less than half that sum for oil or gas. The gap is great, but it is quite likely to be bridged.

* Mr. A. H. Bauer, Superintendent of Electrical equipment of the Pullman's Palace Car Co., has furnished us the following figures showing the cost of operating the electric lights on the Pennsylvania Limited trains:

First Cost of Equipment for 6-Car Train:	
Baggage car	$2,250
Dining car	576
Three sleeping cars at $675	2,025
Observation car	625
Total	$5,476
Average cost of labor per car per day	$1.15
" " " material per car per day	.74
" " " operation per car per day	$1.89
Average number of lamps per car	28
Average cost per lamp per day	6¾ cts.

Mr. Bauer states that their practice is to base all calculations on 24 hours per day, which is correct for estimating the cost of train lighting as used on the Pennsylvania Limited, because the manner of running the trains necessitates using nearly as much light during the day as at night. On this basis the cost per lamp per hour would be but little over ¼ ct., or, including interest and depreciation, estimated at 10%, and supposing the car in service 300 days per annum, the cost per lamp hour is only 0.29 ct. This is not fairly comparable with the other figures given, however, being on such a different basis as to hours of service per day and number of lamps per car.

the volume of light, which is rudely approximate, the cost per year per car of each mode of lighting would be:

	Oil.	Comp. gas.		Carb'ters.
For 130 c. p.	$96.80	$70.98	$82.09	$72.40
For 200 c. p.	$128.70	$90.32	$105.19	$94.06

PERSONALS.

Mr. F. W. Baldwin has been appointed General Superintendent of the Central Vermont R. R.

Mr. W. H. Bower has been appointed Assistant General Manager of the West Virginia Central & Pittsburg R. R.

Prof. Charles W. Spencer, of Cornell University, has been elected to the chair of Mechanical Engineering at the University of Illinois.

Mr. T. R. Sylvanus, of Chicago, has been appointed superintendent of the water supply and waste service at the World's Columbian Exposition.

Mr. Thomas T. Johnston, C. E., has been appointed Principal Assistant Engineer of the Chicago Drainage Commission, with headquarters in the Rialto Building, Chicago.

Mr. L. F. Goodale has been appointed Chief Engineer of the St. Louis, Keokuk & Northwestern R. R. and Chicago, Burlington & Kansas City Ry., with offices at St. Joseph, Mo.

Mr. Edgar Williams, C. E., has opened an office in the Rialto Building, Chicago, as a consulting engineer, making a specialty of designing and constructing sewerage systems, water-works, etc. Mr. Williams has been Principal Assistant Engineer of the Chicago Sanitary District from its inception until Feb. 1, 1892, when he resigned to engage in business as above. Previous to his engagement on the Sanitary District he carried on a general engineering practice in Chicago.

Mr. Ross Kells, Superintendent of Motor Power of the New York, Lake Erie & Western R. R., died March 10, at the age of 52. He was formerly with the Pittsburg, Cincinnati, Chicago & St. Louis Ry., afterwards Superintendent of Motive Power of the New York, Chicago & St. Louis R. R., and later held the same position on the New York & New England R. R. In February, 1887, he became Assistant Superintendent of Motive Power of the New York, Lake Erie & Western R. R., and succeeded to the head of that department about two years ago.

Mr. W. D. Buckner, Chief Engineer, and a party of 22 engineers, rodmen and chainmen, sailed from New York this week for Cartagena, U. S. Colombia, to make the final surveys and prepare for the construction of the Magdalena & Cartagena Railway. The line will run from Cartagena to a point on the Magdalena River, and it is said that it will traverse a productive fruit and mineral district. The road will be owned by a Boston company. President, J. Murray Forbes; Secretary, Thomas R. Wheelock. The project was briefly described in our issue of May 9, 1891.

Mr. John F. Winslow, who died March 10, at Poughkeepsie, N. Y., was one of the leading iron makers of the state, and, with Erastus Corning and John A. Griswold, introduced the manufacture of Bessemer steel into this country, and at their works in Troy, N. Y., made the first steel rails in America. In 1831 he became interested in the production of iron, beginning as managing agent of the New Jersey Iron Co., and in 1837 he became a partner with the late Erastus Corning, of Albany. This partnership, with some changes, continued for thirty years, controlling the Albany & Rensselaer Iron Works. The Bessemer steel patents were introduced into this country by the firm. The most important act of Mr. Winslow's life was in connection with the building of the "Monitor." The firm of which he was a member was convinced by Capt. Ericsson of the practicability of his plans, and made a proposition to the government to construct a vessel in accordance with them for use during the war, the firm taking the entire risk. The building of the "Monitor" was begun in October, 1861. It was launched about three months later, and on March 5, 1862, was delivered to the government and immediately placed in commission. Mr. Winslow was one of the promoters of the Poughkeepsie & Eastern R. R., and at one time its president, and when the Poughkeepsie Bridge Co. was chartered he was one of the incorporators and was chosen the first president of the company.

Sir John Coode, K. C. M. G., Past President of the Institution of Civil Engineers, died at Brighton, England, March 2. He was born at Bodwin, Cornwall, in 1816, and commenced his engineering career as a pupil of the late Mr. J. M. Rendel. He was engaged on the works of the Great Western Railway for some years. He was elected a member of the Institution of Civil Engineers in March, 1849, became President in 1889, and was re-elected for a second year. He received a Telford medal in 1853 for his paper on the origin of the Chesil bank, and made valuable contributions to the discussions upon harbors, sea defenses, tidal action on beaches and marine structures, the construction of groynes, and on river hydraulics. He interested himself in the recent developments of the inland navigation questions and on sanitary matters affecting large towns. He was for many years consulted by the Board of Trade and other Government departments on matters connected with harbors, docks, rivers, and drainage. Many important works were carried out from his designs, including the breakwater and docks at Cape Town, the breakwater at Colombo, Ceylon, the improvement of the river Bar, in Ireland, the harbors of the Isle of Man, and similar works elsewhere. He was a member of the Royal Commission on Harbors of Refuge in 1858-9, and of the Royal Commission on Metropolitan Sewage Discharge 1882-3. The harbor of refuge now in progress at Peterhead, and the new harbor works at Dover are from the designs of himself and his firm. He was a member of the International Consultative Commission on the Suez Canal in 1884-5. In the summer of 1889 he received as President of the Institution of Civil Engineers about 250 American engineers, who visited Great Britain in a body. He was one of the Royal Commissioners for the Colonial and Indian Exhibition of 1886, and acted as President of the engineering section of the International Congress of Hygiene, which held its sittings in London in August, 1891, and the proceedings of which were reported in Engineering News. Sir John Coode twice visited the Cape, the Australian continent, and New Zealand at the request of colonial governments, and many of the harbors constructed or in progress there are from his designs.

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—At the meeting on March 7 Mr. C. F. Hollingsworth read a paper on the Yellowstone Park.

BROOKLYN INSTITUTE OF ARTS AND SCIENCES.—D. S. Jacobus, of the Stevens Institute of Technology, gave a lecture before the Department of Engineering recently on "Experimental Illustrations of the Principles and Properties of Substances Applied in Modern Refrigerating Machines," in which

a general description of the several types of modern refrigerating machines was presented by the aid of lantern slides and working model. Theoretical computations of the relative efficiencies and sizes of compression cylinders in machines employing different vapors were compared with results obtained by experiment, and it was shown that they agreed if the effect of superheating of the gas during admission to the cylinder was included in the analysis.

A theoretical comparison of the relative economy of absorption and compression ammonia machines was compared with results obtained by experiments in order to reduce it to a practical basis, and it was shown that each machine has its own particular field of usefulness in which it will possess the best economy, the absorption machine being theoretically best for low temperatures of brine and high temperatures of condensing water, and the compression best under the opposite conditions of temperature. Special experiments were made in which a freezing mixture, colder than — 100 degrees F. was employed.

The theoretical deductions were mainly abstracted from work now being prepared by Profs. Denton and Jacobus in revising Ledoux's work on Ice Making Machines, and from an article by the same authors in the "Stevens Indicator," Jan., 1892.

L. Duvinage,
Secy., Dept. of Eng.

THE AMERICAN SOCIETY OF SWEDISH ENGINEERS has issued its catalogue of members for 1891-92. This society was organized on March 8, 1890, and was incorporated on July 14, 1890. The present general officers are as follows: Walfrid Sylven, President; Martin Borgstedt, Vice-President; Ernst Ludgren, Recording Secretary; Walthier Swenson, Corresponding Secretary, and Jos. Westesson, Treasurer. The headquarters of the society for New York are 231 Union St., Brooklyn, N. Y. There are three clubs now in existence, that of New York, with headquarters as above given; that in Philadelphia, with rooms at 646 No. Tenth St., and the Swedish Engineers Club of Chicago, which was organized on Feb. 6, 1892, with about 35 members. The President of the New York branch, with 96 members, is Walthier Swenson, and of the Philadelphia branch, with 48 members, Jos. Westesson. Two general meetings were held last year, and altogether twelve papers were presented by members.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on March 16 an interesting description of the "Boston Water-Works" was given by Mr. Desmond Fitzgerald, which was illustrated by lantern slides of various photographs, showing the structures, reservoirs, progress of works, etc. There are no large towns on the Cochituate or Sudbury watersheds, and the population on the watersheds is comparatively small, though larger than on the Croton watershed, New York. The total storage capacity of the watershed, when all the dams and works are completed, will be about 9,000,000,000 gallons. The Sudbury aqueduct is of masonry, 9 ft. wide and 7 ft. 6 ins. high, its cost being about $37 per lin. ft. The aqueduct is carried across some of the valleys on handsome masonry arches, and the Charles River is crossed by a masonry arch of 129 ft. span and 18 ft. wide. The aqueducts are swept out periodically by a machine devised by Mr. Fitzgerald, having revolving rattan brushes. The embankments of dams are of strong gravel, laid in thin layers of 6 ins. or even less, thoroughly wetted and rolled with grooved rollers. A concrete core wall is carried down to the rock, and is faced with cement plaster to make it water-tight. At all reservoir sites the vegetable soil is removed, and either taken to the city parks, or used in filling up shallow places around the edge, all shallow flowage being either filled up or deepened, the depth of water around the edge of the reservoir being about 8 ft. This work costs about 35 cts. per cu. yd. Laboratory tests of water from the top, mid depth and bottom of each reservoir are made every week, and the results carefully recorded.

In the discussion, Mr. Cartwright said that he preferred to use clay in banks, instead of gravel alone. He also said that ordinary concrete with Rosendale cement can be made water-tight, but it should be thrown into place and left without ramming or any such treatment, as that tends to break the bond. Mr. Fitzgerald considered it better to ram the concrete, as it makes the material very hard and compact. Major Sears said he would not use a core wall of any kind if he could get the proper material for the bank, and referred to the Spring Valley and other California dams, which have been fully described in Engineering News. In concrete construction at one of the U. S. forts, the methods of throwing the material from a height, of laying it in place, and of ramming it after laying were considered, and the third method adopted. A few years later it was necessary to remove some of the work, and the concrete had to be blasted, owing to its hardness.

ENGINEERS' CLUB OF PHILADELPHIA.—Business meeting, March 5, 1892. President James Christie in the chair. Fifty-five members and five visitors present. A memorial of Mr. Edward Nichols was presented and ordered to be printed in the minutes. Mr. Barton H. Coffey presented a paper on the Cost of Producing Power in the Internal Combustion Engine. The basis used is the cost per horse-power hour. We must determine the absolute efficiency to calculate the heat required for given I. HP., and, knowing the value of this, the cost of fuel is fixed. The remaining charges will be for attendance, maintenance, depreciation and interest on the investment. The absolute efficiency depends principally on the cycle employed and the diameter of the cylinder. As the cycle known as the Otto is the one in most extensive use to-day, I find that the absolute efficiency can be expressed quite accurately in the form:

$$E = 61 \sqrt{\text{cylinder diameter}}.$$

Under the cost of fuel the author takes up illuminating gas, producer gas and petroleum, and gives for illuminating gas per HP. hour .395 x cost per 1,000 cu. ft. in cents. For producer gas the value is .0105 x cost of coal per ton, as the cost per HP. hour, and for petroleum .0176 x the cost of oil per gallon. As to the cost of cooling water, the author finds that 10 sq. ft. of air surface per HP. will keep the temperature of the cooling water sufficiently low for efficient working, and in cases where water would be an item of expense, the same water could be used continuously. The author estimates the cost of attendance at 22.2 cts. per hour; the cost of maintenance at .05 ct. per HP. hour; the item of depreciation and cost, based on 300 working days of nine hours each, an average cost of $70 per HP., and a depreciation of 10 per cent., with a producer cost of $10 per HP. for the same condition, amounts to .4 ct. per HP., the sum of these quantities giving complete cost per HP. hour. The steam engine is, of course, the principal rival of the engine treated of in this paper, and it is questionable if the combined efficiency of the best types ever rises above 12 per cent. From this figure as a maximum, it ranges all the way down to 1 per cent., depending on the completeness of the steam system and the quality of the design and workmanship. The report of a test of a 170 HP. Crossly gas engine, using producer gas, shows a consumption of but .85 lb. of coal per HP. hour, or an absolute combined efficiency of 21.3 per cent, for the engine and producer. The efficiency of the engine alone is in the neighborhood of 25 per cent. The three chief losses, incomplete expansion, conduction to the jacket, and sensible heat of exhaust, are all within the engineer's possible control. The almost prohibitive price at which this machine hitherto been held will be reduced, and a more general introduction will follow.

Mr. Carl Hering gave some items of cost of the transmission of power from Niagara Falls to Buffalo. The units intended to be used are 5,000 HP. The dynamos are to be coupled directly to the turbine by vertical shafts; 600 to 700 volts at the dynamo is to be transformed to 25,000 volts on the line. Three-phase dynamos are to be used, making 250 revolutions and supplying 2,000 amperes. The cost of the whole plant per unit of 5,000 HP. is to be $180,000, or $36 per HP. This estimate includes generator, line and transformers at each end; line cost alone being $20,000. At present the cost of dynamos varies from $50 to $75 per HP. The total efficiency of the plant is to be 84 per cent. from the shaft of the turbine to the secondary terminals at Buffalo, the dynamo alone giving an efficiency of 96 per cent.

Mr. Wilfred Lewis introduced Mr. J. Bogart, Engineer of the Construction Co., who stated that the Oerlikon Co.'s bid is about as Mr. Hering had given it, but the problem that interests us is rather what will steam-power cost under the most favorable conditions, with coal of a given price, or for how much could a company put in a steam plant and sell to customers power. He also stated that he had received two estimates as to the cost of power under these conditions, and that the problem is by no means an easy one is shown by the fact that the larger of these estimates is about two and one-half times the smaller. The solution must not be complicated by other questions, such as the use of steam for heating, or other purposes, and this makes it a particularly difficult one to handle. Mr. Murphy stated that his recollection was that the cost of pumping water at the eight steam stations in Philadelphia was in the neighborhood of $8 per million gallons, pumped 100 ft., while at Fairmount the cost was $2.

Mr. Bogart said the plant now under way, is capable of developing 100,000 HP. It is proposed to use this first at Niagara Falls, or at the present station by giving power to manufacturers for coming there. Many manufacturing industries take much more horse-power than that stated by Mr. Salom—wood-pulp mills, for instance—and a 3,000 HP. plant is being put in by one company, and a second plant is under consideration. It is in the minds of the company, also, to transmit power to Buffalo, which is a city of a large number of small power establishments. The turbines are to be about 120 ft. below the surface, leaving 20 ft. to spare. The water that can be taken by the tunnel will take a film of 1 3-4 inches off the Falls, the average depth being about 6 ft., as near as we can judge.

H. W. Spangler,
Secretary pro tem.

NEW ENGLAND RAILROAD CLUB.—At the meeting on March 9 the annual report of the Secretary and Treasurer, Mr. F. M. Curtis, showed a membership of 192 and an average attendance of 50 at the regular meetings. The year's expenditures were $307.75, and the club has $156.41 in its treasury. On recommendation of the nominating committee, all the officers of the club were re-elected. The subject of freight car trucks was presented by Jas. B. Brady, representing the Fox Solid Pressed Steel Co., of New York, makers of pressed steel trucks. The Fox truck has the advantages of lightness, strength and durability. It reduces the dead weight of the car 1 to 2 1-2 tons. It is guaranteed to require no repairs for five years unless damaged in accidents. It has been objected that the riveting will work loose; but, although some cars have been running for two years and seven months, no trouble of this sort has arisen. It is modeled on the Boston & Albany truck. The whole weight of the truck, except the wheels and axles, is carried on springs. These trucks are running under five passenger engines on the Pennsylvania Railroad, averaging 4,500 to 6,000 miles per month, and proving very durable. Mr. L. M. Butler said he had the Fox trucks in use under a stone car loaded with 80,000 lbs., and had shown no weakness. If the truck proves, after thorough trial, to give no trouble about the riveting, it will be a remarkable thing. The diamond truck can be built for about $48, ready for wheels and axles, and is about the best of the ordinary styles of truck.

Mr. F. D. Adams said the New York Central built several thousand riveted trucks several years ago, and after running four or five years they were all abandoned, on account of the rivets working loose. Mr. Brady explained that the riveting was done by hand and by contract work, and the pieces riveted together were thick. In the Fox pressed steel truck the plates are thin and the riveting is done by hydraulic power. Mr. Coughlan thought the truck might be subject to corrosion from the urine of cattle and the drippings of refrigerator cars. Mr. Adams said that the iron cars had given much trouble by corrosion, and he thought the pressed steel truck might prove to be lacking in durability from this cause.

Mr. Brady said none of the trucks now running had shown noticeable corrosion. Several express trains on the Old Colony are running with this truck. The truck frames, without center plates, spring or journal boxes, cost $110 per car. Mr. Marden thought every truck ought to be so designed that the brake could be hung on the outside. The adoption of a standard truck would be a great benefit to the railways.

At the next meeting, on May 18, the subject for discussion will be Rule 8 of the Interchange Rules.

COMING TECHNICAL MEETINGS.

CENTRAL RAILWAY CLUB OF BUFFALO.
March 25. Secy., Jas. Macbeth.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 1. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 1. Secy., O. von Geldern, 319 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
April 2. 1122 Girard St. Secy., J. C. Trautwine.
SWEDISH ENGINEERS' CLUB.
April 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
April 2. Union Station, St. Paul.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 4. Secy., C. L. Annan.
WESTERN SOCIETY OF ENGINEERS.
April 6. Secy., J. W. Weston, 330 La Salle St., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
April 6. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 6. Secy., F. Collingwood, 127 East 23d St., New York. "Brooklyn Intercepting Sewer." Willard Beahan.
ENGINEERS' CLUB OF MINNEAPOLIS.
April 7. Public Library Bldg. Secy., F. W. Cappelen.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 8. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
April 9. 194 Third Ave. Sec., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 9. At Roanoke. Secy., J. E. Schick, Roanoke, Va.
ENGINEERS' CLUB OF KANSAS CITY.
April 11. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC SOCIETY.
April 11. Loan & Trust Bldg., Milwaukee. Secy., M. Skinke.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., Geo. H. Angell, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 12. Secy., A. H. Porter, 50 Euclid Ave.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 12. Occidental Block, Seattle. Secy., E. H. Warner.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
April 14. Secy., O. H. Landreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 14. Secy., Edward Mead, Norton Building.
MONTANA SOCIETY OF CIVIL ENGINEERS.
April 16. Secy., F. D. Jones, Helena.
WESTERN RAILWAY CLUB.
April 19. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 19. Secy., J. H. Harlow, Pittsburg, Pa.

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AND
AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: one year, $5.00; 6 months $2.50; 4 months, $2.00; single copies, 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses. No club rates allowed.

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

A gratifying evidence that we are again becoming a maritime nation, and gradually recovering lost ground, is the establishment at Cornell University of a graduate course in Marine Engineering and Naval Architecture. We believe there is talk of establishing two or three other such schools, but this is the first in the country to be organized, and in running order, as it now is. As such, it marks a distinct epoch in the growth of American technical education, if not also in American shipbuilding. Prof. W. F. Durand is in immediate charge of the school, but it constitutes a department of Sibley College, of which Prof. R. H. Thurston is director, and we have no doubt that the new school will have the benefit of his eminent skill as an instructor and organizer, and will derive great benefit therefrom. The students are assumed to have graduated in mechanical engineering and the graduate course is for one year only, but this year is entirely directed to ship design and marine engines. There ought to be abundant room for at least one such school, and in our opinion it is a promising profession for a young man with a taste for it to adopt.

We complete with this issue the article of our car-lighting series which has caused us more trouble than any other, that on the comparative cost of the several systems of lighting. It is ordinarily a delicate question to enter into, while yet a fundamental one, which could not be neglected or passed over without making any investigation of the "Comparative Merits of Various Systems of Car-Lighting" somewhat of an absurdity. Disguise it or deny it as we will, comparative cost is the first thing a manager wants to know, and needs to know, in deciding whether to use this or that system. If he finds any great difference in price, he reasonably may and does require strong evidence that any other system is better, safer or more durable, before he will adopt it. If he finds no such difference, questions of safety and comparative convenience have a greater influence. To claim that the figures given elsewhere are precisely accurate, either for any one road or as a general average, would be absurd; but we do hope and believe that the several items err only by slight percentages from a fair average, and that sufficient details are given to enable any one to make the proper substitutions for his own special conditions. The general result seems to us to be much what reason indicates, and much the same as in house-lighting. It is beyond question that oil lamps furnish the cheapest mode of house-lighting if we assign no money value to their inconveniences, smells, injuries to furniture and added risks of fires; but it is equally beyond question that these intermediate items are rated so high by the majority of men that when they have the choice between oil and gas for house-lighting they almost invariably regard gas as the cheaper for them (in the sense of giving more for the money) and so prefer it. Similarly, as respects the choice between city gas and a so-called "portable gas-plant," when there is choice the preference is ordinarily given to the fixed gas as somewhat cheaper and somewhat the most desirable for use, but with much less marked difference between the cost of the two than between the computable elements of the cost of oil and either one of them.

The pig iron output this month has so far been at the rate of about 11,000,000 net tons per annum, the largest on record. Consumption is also very great, the World's Fair work alone requiring a sensible addition to the usual demand. Nevertheless, prices are falling and are now very low. It is even reported that 20,000 tons of Alabama pig iron were sold in Detroit last week for delivery in the last half of this year at a rate yielding only $9 per ton at the furnaces, which is about the lowest point, we think, that pig iron has even touched in any part of the world. Pittsburg quotations for No. 2 foundry pig are now hovering about $14. It has been expected that these low prices would knock out "Southern pig," but they do not seem to. Southern pig comes up smiling, and meets all attacks easily enough, so far as yet appears, though enormous consolidations are proposed in order to reduce expenses. The permanent fact underlying the iron question, like the silver question, is that modern processes and facilities are greatly cheapening the cost of production, and no combination can long resist the natural effect of this fact.

Said a prominent member of the American Institute of Electrical Engineers not long ago: "The developments in electrical science and practice come so rapidly that I despair of keeping up with them. A couple of years ago I considered myself fairly well posted as an electrical engineer, but my time has been taken up in other work since that time, and I feel now like an ignorant amateur in discussing electrical problems."

Certainly if electrical engineers find it difficult to keep abreast with the progress in their peculiar field, mechanical and civil engineers may be expected to abandon the task entirely. But while this may do for the older members of the profession, who have made their reputation in special lines and find abundant occupation in keeping up with the progress in their own specialties, every young engineer who aspires to something more than mediocrity, should gain all the information he can on the progress of electrical work.

It is not meant that the mechanical or civil engineer should abandon his especial profession and take up electrical work, for the number of electrical engineers promises to increase faster than the demand for their services. It requires no great foresight to see, however, that with the constantly increasing part which electricity is playing in modern industry, the engineer who aspires to high rank in his profession ought to be familiar with the possibilities and limitations of electrical work. He should be able to judge for himself in cases where the relative advantages of electric and other motive power must be decided, not relying solely on the representations of possibly biased experts. The civil engineer asked to report on the value of a water power, the mining engineer giving an opinion on the cost of working a mine in a remote mountain district, the mechanical engineer planning the machinery of an extensive shop, all need to know what can be done with electricity in order to reach an intelligent decision.

It will be noted that the use of electricity in which engineers are chiefly interested, is in the transmission of power. It is not of especial importance that they should be familiar with telegraphy, telephony or electric lighting; but the use of the electricity for the transmission of power comes into competition with all the other modes of power transmission with which engineers are familiar, and makes possible its transmission over distances where no other method is practicable. The best exposition we have seen of what is now possible and practicable in electric power transmission is contained in the paper by Mr. Carl Hering, published elsewhere in this issue, and the discussion upon it by Prof. Elihu Thomson and other acknowledged authorities. It is especially valuable because it is reasonably free from technicalities; and even engineers whose knowledge of electrical practice is very small can obtain a clear idea of how the long distance transmission of power has been accomplished and is likely to be accomplished in the future.

Aside from its technical importance, when one fully appreciates what has been done and is likely to be done in this almost untouched field of engineering work, the subject becomes one of absorbing interest. Think of carrying 180 HP. over a distance of 100 miles through three slender copper wires, little more than 1-8 in. in diameter, and doing this with a loss in transmission of only 20 to 30 per cent., and the company which performed this feat talks of transmitting 1,000 to 5,000 HP. from Niagara to Chicago, over 500 miles, with a loss of only 25 to 40 per cent.

Even the more modest feats which have been performed, and which are now proving their efficiency in daily service, read like a fairy tale. Witness the plant at Ouray, Colo., described in our issue of March 12. It takes a thousand horse-power from an insignificant mountain brook, under a head of about 500 ft., and sends a current of electric energy four miles up the mountain side to work the machinery of mines situated 12,500 ft. above sea level, in the region of perpetual snow.

There is just one other point worth a little attention, and that is that electrical engineers seem to need the counsel and approval of other members of the profession. Electrical engineers, as a rule, seem to have a surplus of sanguine enthusiasm, born of the fact, perhaps, that they are as much inventors as engineers. All things are possible with electricity, is their motto, and what are not possible now, may be expected to be revealed in an early issue of the "Patent Office Gazette." It is a somewhat comical illustration of eagerness to reach results by the shortest possible method that the first measurements which were made of the power transmitted from Lauffen to Frankfort showed considerably over 100 per cent. efficiency. They were getting more power at Frankfort than was put into the wires by the turbine and dynamo at Lauffen. As it was hardly likely that the current had swelled on the way or that any unauthorized person had placed additional electricity on the line en route, it was concluded that the measurement of current or voltage was incorrect.

Doubtless the ampere meter and voltmeter as ordinarily used are truthful instruments; but when any work of great importance is to be measured, especially if it is accomplished with new and unfamiliar mechanism, the mechanical engineer will like to see their truthfulness attested by some mechanical measurements of the power developed.

To instance a parallel case, the steam engine indicator is a truthful instrument when properly handled and interpreted; but we all feel a little more confident in its records on a new type of engine if it is checked by a brake test.

THE MASSACHUSETTS RAILROAD COMMISSION REPORT.—II.

In our last issue we were compelled for want of space, to drop our review of its contents in regard to steam heating, with a summary of the extra-official causes which pushed forward the reform in 1887 and thereafter.

In the meantime, to return to official action in Massachusetts, in its 1887 session the legislature passed an act prohibiting the use of common stoves, or any heater not approved by the railroad commission, and instructing the board to investigate the whole question. May 1, 1888, the board reported that not only was steam heating from the locomotive the safest, but also the most economical, and recommending that separate heating be permitted only under exceptional circumstances after Oct. 1, 1889. There was opposition, however, and the legislature merely instructed the board to investigate further and report. This it did in the reports submitted in the spring of 1889, 1890 and 1891.

The continued progress shown in these reports led the legislature at its last session to pass a mandatory law forbidding any company to heat any car by a separate heater, except in an emergency or by special permission of the commission. The reform was

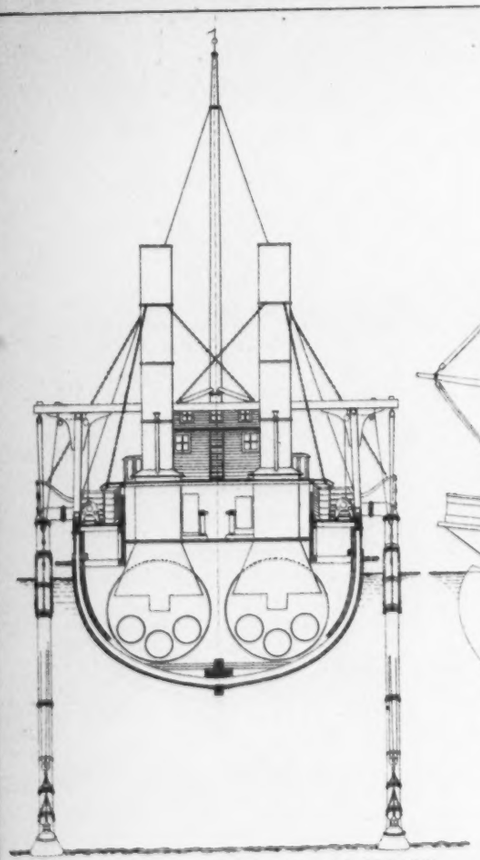


FIG. 1. CROSS SECTION SHOWING BOILERS.

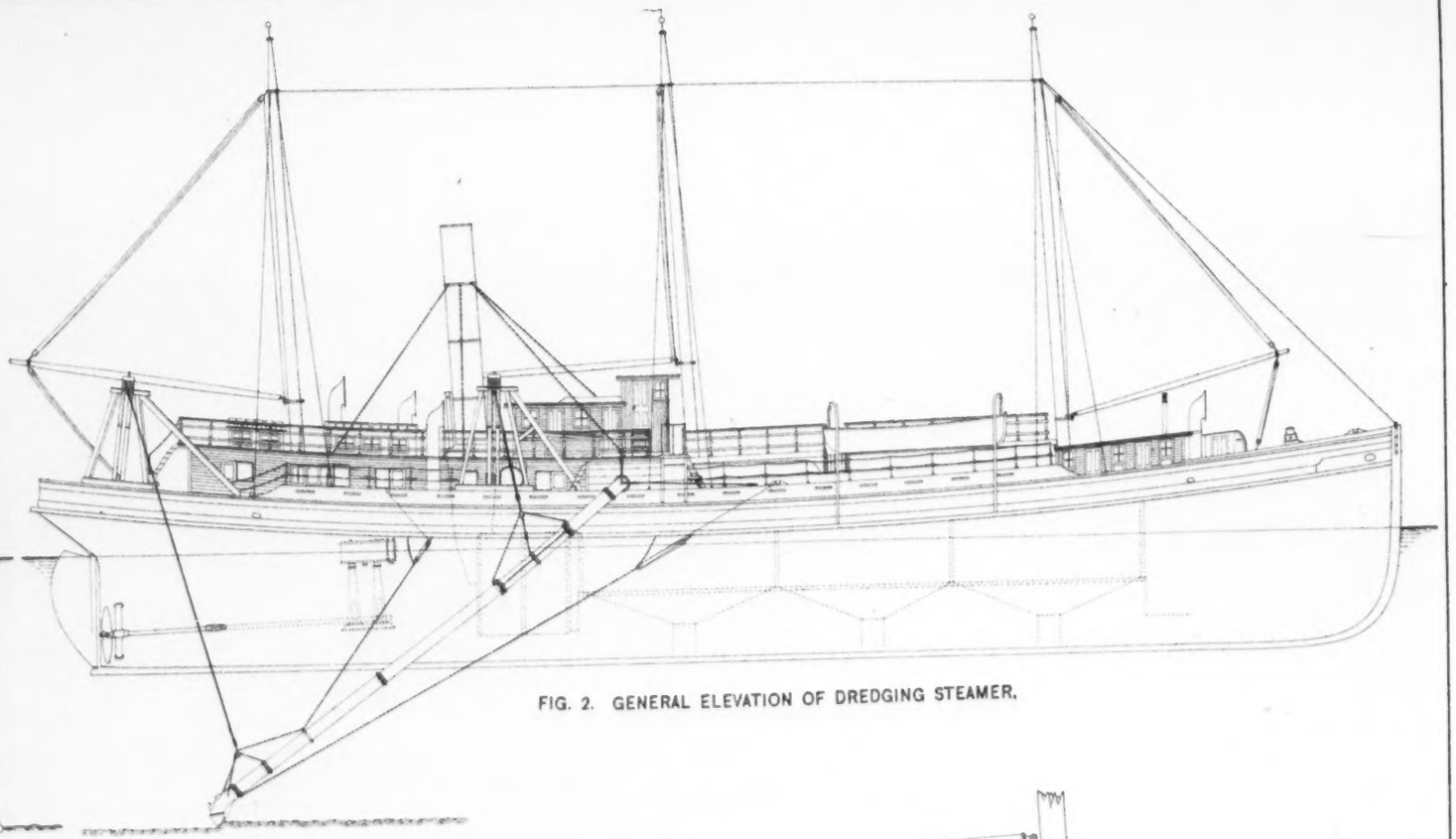
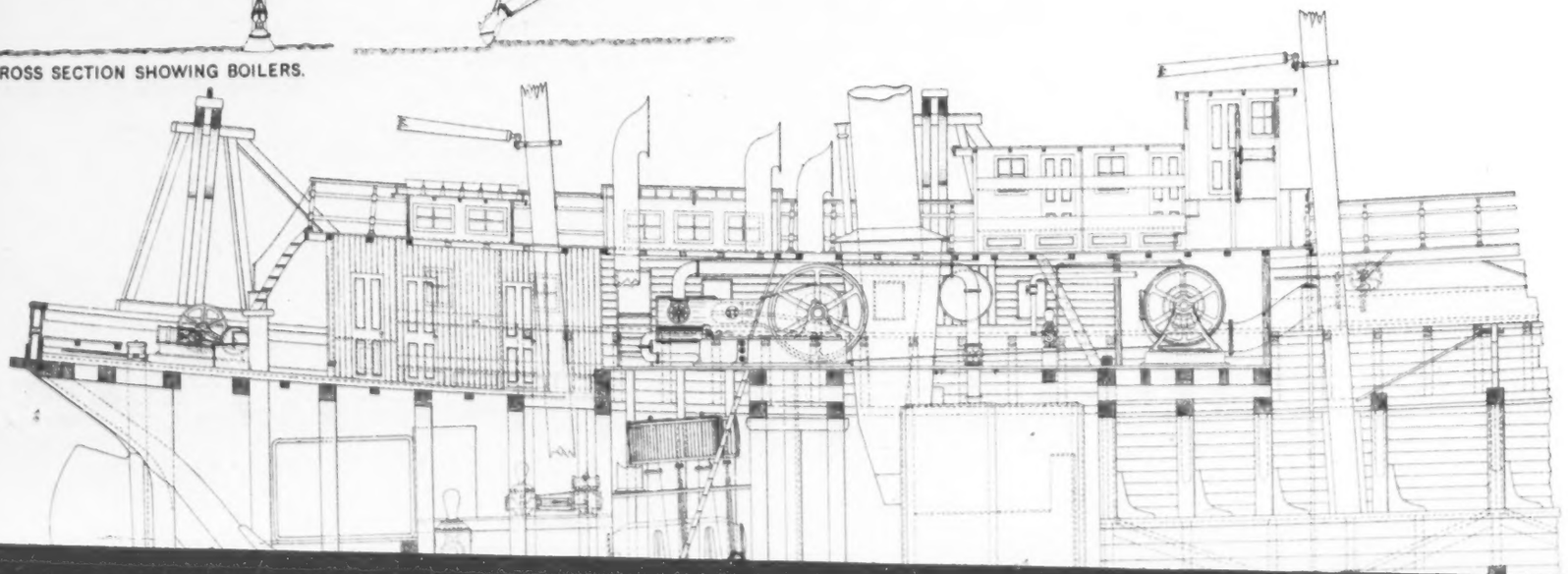


FIG. 2. GENERAL ELEVATION OF DREDGING STEAMER.



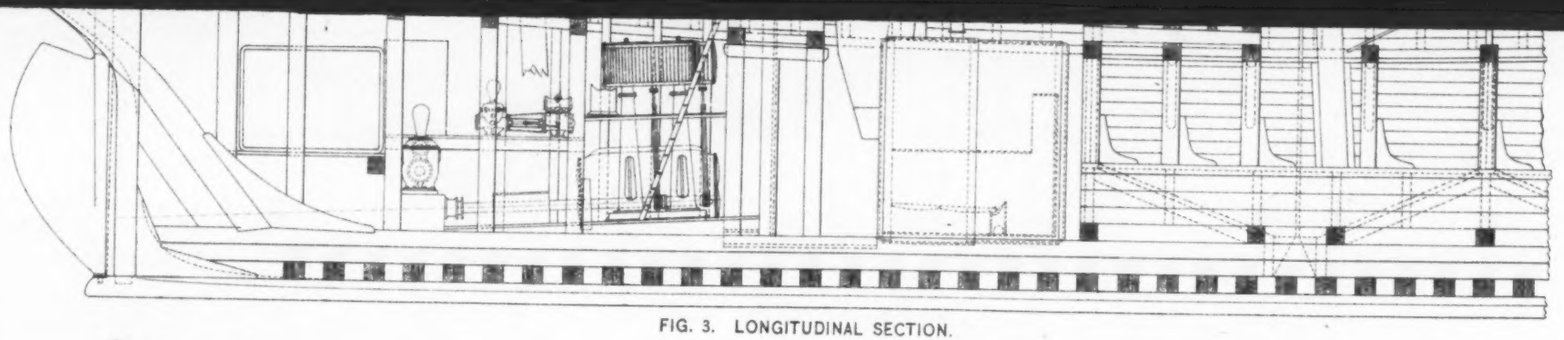


FIG. 3. LONGITUDINAL SECTION.

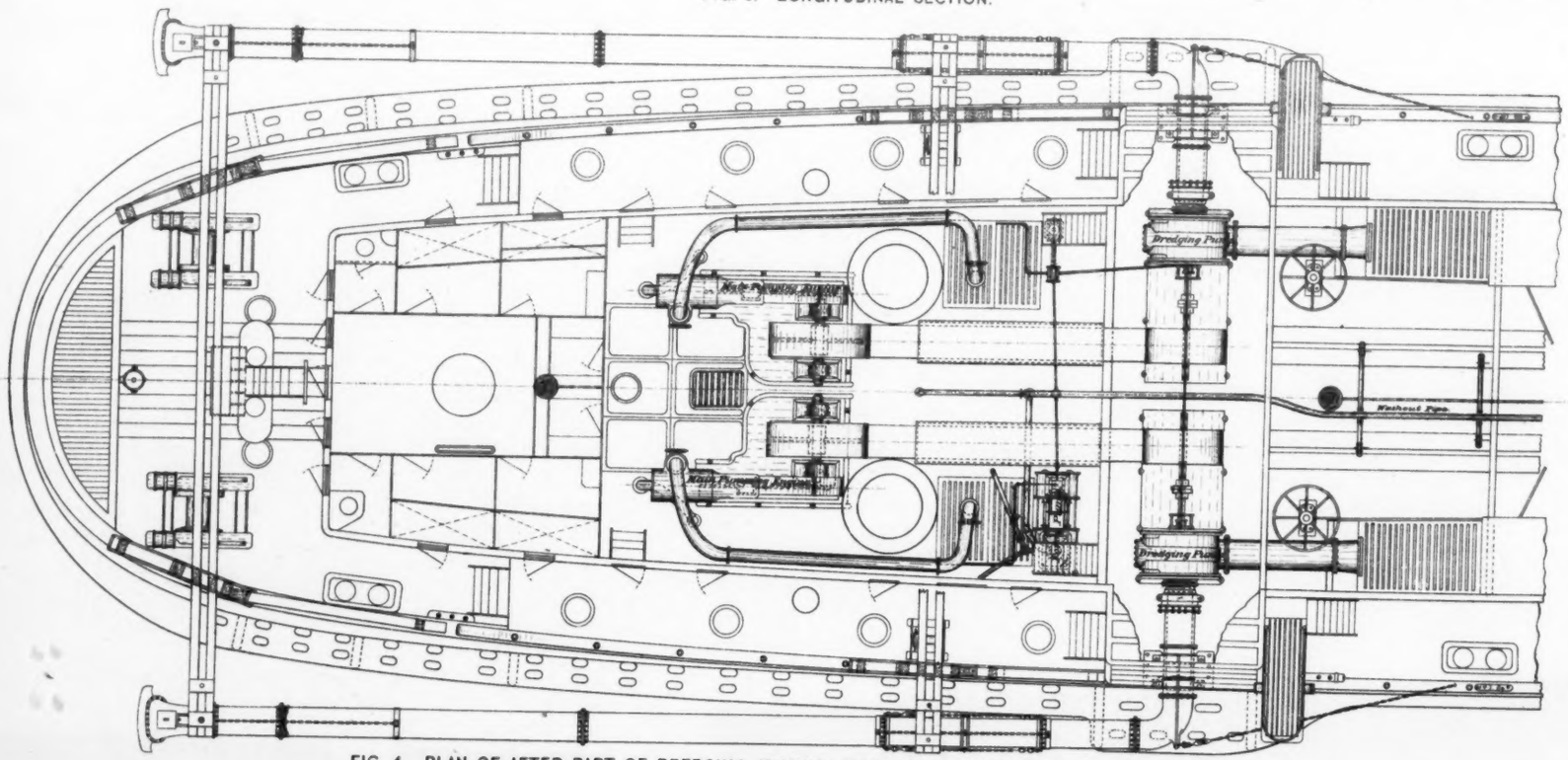
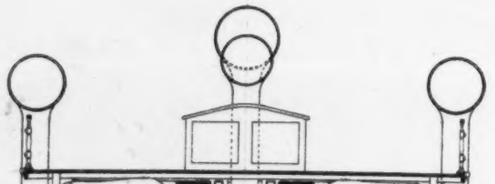


FIG. 4. PLAN OF AFTER PART OF DREDGING STEAMER SHOWING ARRANGEMENT OF MACHINERY.



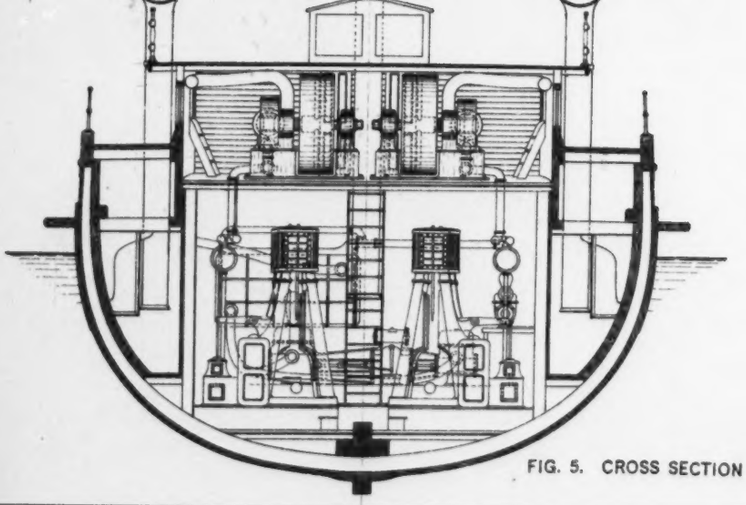


FIG. 5. CROSS SECTION SHOWING PUMPING ENGINES.

DREDGING APPLIANCES USED IN IMPROVING ENTRANCE
TO NEW YORK HARBOR.

Joseph Edwards Dredging Co., Contractors.

CHAS. HART & SONS, LITH., 90 VESEY ST., N. Y.

already nearly accomplished, and yet the value and efficiency of this law in hastening the laggards is shown in the following record of progress in each year:

	Prior to 1887 rep't.	1887-8.	1888-9.	1889-90	1890-91.
Cars equipped.....	266	355	542	181	944

The report now before us proceeds to quote from the committee report submitted at the meeting of the American Railway Association, Oct. 14, 1891, as to the requirements of a good system of steam heating, and quotes their conclusion that "about one-seventh" of the entire passenger equipment of the United States was then equipped for steam heat, which, as we stated at the time, is far below what the returns which we collected indicate, and far below the truth. In our issue of June 7, 1890, we gave detailed statistics, whose substantial accuracy has never been questioned, and is not questionable (they being based chiefly upon direct reports from the several companies given in detail) showing that 7,391 out of an estimated total of 30,000 passenger train cars were even then equipped for steam heating, or nearly 25% of the whole. The commission doubtless feels a natural preference for quoting the figures of a semi-official committee on a question of this kind, rather than those collected by the private enterprise of a technical journal; but had it realized more fully how much easier it is to err by omission than by commission in records of this kind, and the prodigious capacity of an unpaid "committee" for not looking far beyond its nose, it would not have misled the public, and done this journal a tacit injustice, by giving official authority to such a plainly imperfect report.

The commissioners' report next takes up current practice in manning freight trains, with the result that one brakeman for every ten cars is found to be the general practice, though the board disclaims any implication that this is in all cases sufficient. Prof. Geo. F. Swain, the commissioners' bridge engineer, gives a detailed report, showing that there are approximately 10¾ miles of bridges in the state, there being 172 stone spans, 573 wooden fixed spans and 903 iron fixed spans, with 28 drawbridges, all but 6 of them being jack-knife draws; the last not a very creditable fact, since the jack-knife draw is a dangerous mode of construction. Most of these jack knife draws, moreover, are around Boston, where the speed may be slow, but the traffic is very heavy.

The average expenditure in Massachusetts for the past ten years on repairs and renewals of bridges has been about $1,000,000 per year, to which was added $1,450,000 in 1888 and 1889 as a direct effect of the Bussey bridge disaster. The average was somewhat exceeded last year also.

The commission renews its appeal for some provisions against trespassers in the interest of humanity, justly pointing out that nearly as many of them are killed as of passengers and employees together. We have so recently [Eng. News, Feb. 20, 27, March 5], reviewed the railway casualties to persons in Massachusetts as compared with those in New York, Great Britain, Germany and the several sections of the United States, that we refrain from analyzing at this time any of the accident statistics of this report.

On the question of safety appliances, especially automatic couplers, the report has some earnest words to say. It reviews the statistics of casualties and the appointment of the committee of commissioners which met Nov. 10, 1891. It quotes this journal as authority for the statement that on Jan. 1, 1891, 100,000 freight cars, or 10% of those in use, were equipped with M. C. B. couplers, and then adds: "The statistics of the Interstate Commerce Commission for the year ending June 30, 1890, indicate that these figures are too large." With all respect to the commission we doubt the accuracy of that statement. They rather indicate that the interstate statistician took the face of his returns, which were in very many cases incomplete, without taking the same pains that we did to extort the full facts by repeated importunities.

The report then proceeds to give in other words the argument and table which we gave in our issue of April 25, 1891, showing that until the number of cars equipped with M. C. B. couplers exceeded one-half of all in use, the number of coupling casualties would tend to increase, rather than decrease, with each addition to the number of M. C. B. couplers in use, a fact which has a very important bearing on the desirability of making the transition period as brief as possible. After reprinting our table in slightly modified form, the report adds:

The foregoing table corresponds with a table published in Engineering News, April 25, 1891, in which the same results were reached by a different process of reasoning.

These figures, however, are based on an erroneous assumption. The transition period will not be so dangerous as the table indicates. The M. C. B. couplers are not and will not be evenly distributed throughout the country. For any given number of M. C. B. couplers, the number of couplings of two such couplers together will exceed the estimates given in the table, for the reason that cars fitted with such couplers are in fact to a large extent kept together on the same lines or in similar service. For every additional coupling between two M. C. B. couplers, the number of couplings between an M. C. B. coupler and a link and pin is reduced by two.

The second paragraph above does us an injustice, which we are sure was unintentional, but which is none the less annoying. Our figures were based on no "erroneous assumption," because we expressly said that they were subject to the correction which the commission note above, and could only be regarded as indicating tendencies, not the absolute number of "matched" and "mismatched" interchangings. The tendency of "mismatched" couplings to increase until about half of all the cars in use are equipped with the M. C. B. couplers remains the same after making the correction which we and the commission alike suggested.

The commission refrain from any specific expression of opinion as to the expediency of legislation, adding only: "One thing is clear, that something can be done and therefore must be done, to put a stop to this killing and maiming of 8,000 employees per year." We do not feel bound to be so cautious, and therefore repeat what we have said before, that in our judgment the hour cometh and now is when equitable and cautiously drawn mandatory legislation forbidding the use in interstate commerce of cars not equipped with M. C. B. automatic couplers after a certain number of years (say after 1900 at latest) is called for, and would be productive of good. Congressional interference to establish some one standard, on the contrary, would in our judgment be productive of unmixed harm.

The subject of fenders for electric street cars, which was exhaustively discussed in the last report (Eng. News, Feb. 21, 1891), is again taken up. The law requiring street railway companies to equip their cars with fenders approved by the Commission was repealed by the last legislature, and no more progress seems to have been made. The Commission states that it knows of no efficient fenders suitable for all kinds of track and cars, although some tests of a recently invented fender, made a short time ago in the presence of the Commission, showed rather encouraging results. The West End Street Railway Co. is rapidly equipping its lines with long 8-wheel cars. The difficulty of the problem is diminished by this, but it cannot be said that the problem has been solved.

In discussing the increase of street railway accidents in our issue of July 11, 1891, we showed that accidents are about twice as frequent with the electric cars of the West End Ry. of Boston, as with the horse cars of the same company. Practically the same proportion continued through the past year, there being one accident by horse cars for each 105,528 miles run, and one by electric cars for each 55,963 miles run.

The phenomenal growth of electric railways has continued during the past year. The following figures help one to realize how recent an innovation the electric railway is:

	Date. Sept. 30, 1889.	Sept. 30, 1890.	Sept 30, 1891.
Miles of Elec Ry. in operation in Mass	50¾	160	289

We have left ourselves no space to speak of several other excellent features of the report, like the remarks on train brakes, where practical tests to teach passenger engineers (and their superior officers) just how much can be done in emergencies are wisely recommended. The Board also show that there are 116 crossings of railway tracks at grade by street railways, and that the increasing use of electric power makes this especially dangerous. They also give some statistics of delayed trains, which we shall (hope to) study later in comparison with the British returns. They appear to show a less percentage of delays than the latter.

For the first time in the history of Massachusetts railways, we imagine, there was no increase, but an actual decrease (of two miles) in the miles of road. There was, however, a considerable increase in traffic, which has about doubled in ten years. The evil practice of reporting switch engine mileage as "train" mileage (p. 116 of report) should be stopped.

RAILWAY EARNINGS FOR 1891.

Owing to the general industrial depression and the largely decreased railway construction of 1891 as compared with the previous year considerable interest attaches to the results from operations of the various railways of the country for the year just passed. The influences bearing on the year's traffic and revenue are yet fresh in the minds of our readers, and need be mentioned but briefly. Most of them were remarkably unfavorable, and the natural observation after reviewing the figures given below is that the outcome has proved much better than the conditions in the early months of the year indicated. Among the influences having an unfavorable bearing upon the year's traffic were the short crops in 1890, making a heavy decrease in the grain movement, which has so strong an influence upon the prosperity of a large portion of our railway system; the strike in the Connellsville coke region and the general depression in the iron trade; the unsatisfactory condition of the lumber trade in the Pacific States; the continued decline in the price of cotton in the South, and the general reaction in all industry from the previous era of buoyancy, resulting largely from the financial disturbances in the fall of 1890. Against these we have the great crops of 1891. These, however, affected only the closing months of the year, and notwithstanding their beneficial influences the conditions remained unfavorable throughout the year in many sections.

In its issue of Feb. 27, the "Commercial and Financial Chronicle" gives a detailed statement of gross and net earnings covering 135,612 miles of railway, or about 79.3% of the total mileage of the country. Roughly speaking these figures cover nine-tenths of the railway business of the country, and are fairly representative of all sections. Moreover, they have the additional virtue of being published very promptly after the close of the year. The Canadian Pacific, Grand Trunk, Mexican Central and Mexican National are the only roads outside the United States included in the figures. Table 1, compiled and arranged from the "Chronicle," gives the gross and net earnings of 219 railways for 1890 and 1891.

These figures are far more instructive than any

TABLE 1.

Table showing by Groups the Gross and Net Earnings and Mileage of 219 Railways for 1890 and 1891, together with Gross and Net Earnings per Mile of Railway for 1891.

Section or group, and no. of railways.	Gross earnings 1891. $ = 1,000.	Gross earnings 1890. $ = 1,000.	Inc. or Dec. per c.	Mileage 1891.	Mileage 1890.	Net earnings 1891. $ = 1,000.	Net earnings 1890. $ = 1,000.	Inc. or Dec. per c.	Gross earnings per mile of railway 1891.	Net earnings per mile of railway 1891.
N. Eng. (12)	$62,468	$61,104	+2.26	4,673	4,606	$18,906	$19,932	−5.15	$15,342	$4,641
Tr. Lines (17)	314,317	305,203	+2.9	24,134	23,803	96,119	94,544	+3.78	13,077	4,089
An. Coal (16)	143,248	135,623	+5.6	4,826	4,794	36,244	33,897	+6.93	29,668	7,491
Mid. Sts (12)	52,206	49,793	+4.72	4,793	4,700	18,011	17,076	+5.47	10,892	3,757
Mid. W'n (32)	61,532	56,785	+8.35	10,960	10,903	2,1090	19,709	+7.05	5,614	1,925
No'w'n (21)	128,964	122,061	+5.65	24,168	23,959	46,570	41,685	+11.7	5,336	1,922
So'w'n (14)	94,416	91,547	+3.04	19,279	19,052	27,097	25,094	+7.98	4,897	1,405
Pac. Coast (23)	147,778	142,195	+3.92	25,343	24,663	55,117	49,493	+11.4	5,831	2,174
So'n (40)	87,101	82,075	+6.12	15,103	14,094	28,339	26,115	+8.52	6,180	1,876
Mex. (2)	11,580	10,181	+13.74	3,021	2,745	3,850	3,251	+18.4	3,833	1,274
U. S. (219)	1,103,630	1,056,567	+4.45	135,612	132,811	353,353	330,797	+6.82	8,136	2,605

comment which can be made upon them. Perhaps the most noticeable feature is the universality of the gain, there being no group showing a loss in gross, and but one, the New England, showing a decrease in net earnings; moreover, one road in this group the Boston & Albany, shows a decrease of $1,106,805, or more than the decrease for the whole group. An other point which the table shows strikingly is the difference in the character and density of traffic between the different groups. Taking the three groups having nearest an equal mileage, viz., the Pacific, Trunk Lines and Northwestern, we find that the gross earnings per mile of road are respectively, $5,831, $13,077 and $5,336. It will also be noticed that the increase in net earnings has been relatively greater than the increase in gross. This is to be accounted for in two ways. In the first place the rates in 1891 were generally better maintained than in the previous year, and in the second place the outlays in betterments and improvements were much smaller in 1891 than in 1890.

To bring out the results of the year's operations more clearly we give in Table 2, condensed from the "Chronicle," the earnings of a large number of lines for each month of the year.

TABLE 2.

Table showing by Months the Gross and Net Earnings of Railways in the United States for 1890 and 1891.

Month and no. of railways.	Gr'ss earn. 1891. 1=1,000 $	Gr'ss earn. 1890. 1=1,000 $	Inc. or dec. p. ct.	Net earn. 1891. 1=1,000 $	Net earn. 1890. 1=1,000 $	Inc. or dec. p. ct.
Jan. (125)	50,066	46,208	+ 8.35	13,972	13,464	+ 2.1
Feb. (118)	45,317	43,484	+ 4.21	12,347	11,492	+ 7.43
Mar. (140)	53,050	52,656	+ 0.75	16,036	15,929	+ 0.67
Apr. (135)	52,988	52,901	+ 0.16	15,906	15,381	+ 3.41
May (131)	53,440	55,343	− 3.44	16,783	17,300	− 3.49
June (128)	50,520	48,387	+ 4.41	15,800	14,077	+ 12.2
July (143)	57,847	54,201	+ 6.73	18,913	17,245	+ 9.67
Aug. (137)	62,475	59,543	+ 4.92	22 510	21,333	+ 5.52
Sept. (148)	66,147	61,552	+ 7.46	24,896	22,636	+ 10.32
Oct. (146)	73,055	67,209	+ 8.70	27,934	25,212	+ 10.8
Nov. (138)	67,458	62,545	+ 7.86	23,718	20,795	+ 14.06
Dec. (132)	64,137	58,870	+ 8.95	21,071	18,406	+ 14.48

As would naturally be expected this table shows that the last half of the year, when the effect of the large crops began to be felt, exhibits much better results than the first half. Summarizing the earnings for the first six months we have a gain of only $6,200,000 in gross and only $3,100,000 in net, while for the year the gross gain is $47,067,000 and the net $22,536,000.

In considering the prospective construction of the present year these figures have little significance except in so far as general prosperity furnishes a basis for the expenditure of money in new extensions, other things being equal. Increased business and earnings are generally followed by increased liberality in the expenditure of money in improving old roadbed and equipment. From present indications this will be the case this year, as was stated in the comments accompanying the map of prospective railway construction in our issue of March 5, when, as far as we can judge from the present outlook, the prospects were fairly stated.

The Tampico harbor, after two years' work under Mr. E. L. Corthell as engineer, is now open to commerce with 20 ft. of water over the bar. The two jetties are 1,000 ft. apart and 7,000 ft. long. This is now the only harbor on the Mexican Coast of the Gulf where steamers of deep draft can load and unload at wharves equipped with railway tracks.

Coal gas can be manufactured as cheaply as water gas, according to Horace A. Allyn, President of the New England Association of Gas Engineers. The fact that the water gas process can be regulated more readily and that a water gas plant can be forced to its full capacity on short notice without injury is an important point in its favor. Mr. Allyn questions whether any gas company is doing its full duty toward the city it supplies if it does not add to its coal gas plant a water gas apparatus sufficient to meet any emergency that may arise. The opinion of those best qualified to judge is that a mixture of about two parts coal gas to one of water gas gives the most general satisfaction.

The World's Columbian Exposition management has awarded a contract for cast iron pipe and castings, the specifications for which were given in our issue of March 12, to the Addyston Pipe & Steel Co., Cincinnati, O., at $20.24 per ton of 2,000 lbs. for straight pipe, and $38 per ton of special castings. The contract for three iron bridges over the lagoon has been awarded to the Massillon Bridge Co., Massillon, O., at $15,900. We shall publish details of these bridges later. A contract for laying iron pipes for sewage and compressed air has been awarded to T. C. Brooks & Co., of Jackson, Mich., at $13,118.

LETTERS TO THE EDITOR.

IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR.

Sir:—Mr. Joseph Edwards has recently contributed to the Transactions American Society of Civil Engineers a very valuable paper on Harbor Work, in which recent improvements in dredging plant are well illustrated and the fact established that New York Harbor belongs to the class in which dredging can be relied on to give permanent results.

The plan of the Board of United States Engineers for improving the entrance of New York harbor was to construct a stone dike south southeast from Coney Island for a distance of about four miles, or practically closing one-half of the entrance of the Outer Bay. As the depth of the channels into this harbor is largely due to the funnel-shaped entrance from the ocean, it is somewhat questionable what the result might have been if this project had been carried out.

Fortunately for the interests of commerce, Congress, in making appropriations for this improvement, so limited its use that dredging was the only practical means in which the law could be complied with.

Under the various appropriations since 1884 the Main Ship and Gedney's Channels have been deepened to a depth of 30 ft. at mean low tide, at a total expense of about $1,285,863, or about one-fourth of the estimated cost of improving the entrance by means of a stone dike south from Coney Island.

An examination of the charts of New York Harbor rather indicates that a mistake has been made in the selection of channels on which work has been done, as well as that on which it is proposed to expend future appropriations.

From the head of East Channel to the west end of Gedney's Channel by the East Channel is 27,000 ft.; by the Swash Channel, 34,000 ft.; and by the Main Ship Channel, 52,000 ft.

The amount dredged from the Main Ship Channel in the improvements up to the present time has been about 3,200,000 cu. yds. Two-thirds of this amount if cut from the lower end of East Channel to the deep pool at the west end of Gedney's Channel, (only 4,000 ft.), would have opened a much better channel from the Narrows to the Atlantic, and over four miles less in distance than the one improved.

As the slope of the water surface from the Narrows to the ocean, at ebb tide, by the different channels must be inversely as their lengths, it is very evident that the current through the East Channel when improved, would be nearly double that by the Main Ship Channel.

The 30-ft. depths in the East Channel have always been maintained by the currents in better shape than in the other channels, and also have the advantage of a funnel-shaped entrance from the Narrows, through which the currents are concentrated in the lower portion of the channel during ebb tide, and would be very effectual in maintaining the channel when once improved. The contemplated improvement of the Swash Channel would require a much larger amount of dredging, would be 6,000 ft. greater distance, and would not have an entrance from the Narrows suitable for concentrating currents through the cut. With these facts, as shown by the reports and charts of the Government engineers, the question naturally arises, why should not the East Channel entrance be improved. Geo. Y. Wisner.

RAILS FOR STREET RAILWAYS.

Sir:—While your valuable paper has discussed very fully the various styles of rail adopted by different railways, I am unable to find anything satisfactory pertaining to street-car rails. The rail desired and demanded by the public is one permitting the tracking of vehicles generally, and permitting also easy turning out and egress therefrom, without undue racking of running gears, and frequent destruction of wheels. Will you kindly therefore give me the latest improved section of street-car rail covering the foregoing requirement, and if not too much trouble, the practice in New York or any other city where this question has been agitated? W. T. Brooke,

Norfolk, Va., March 9, 1892. City Eng.

(We know of no information of any importance in regard to street rail sections which has not been given already in these columns.

In our issue of Aug. 9 and Oct. 25, 1890, we illustrated the 82-lb. grooved head girder rail adopted for the Broadway and Third Avenue cable lines, New York, and the 70-lb. side-bearing girder rail used by the West End Ry. Co., Boston. The grooved head is the best form for well paved streets, but its advantages are largely lost when the paving is bad and ruts and holes form along the side of the rail. For ordinary streets the side-bearing form of head is extensively used. The Fourth Avenue line, New York, has recently laid the Gibbon duplex rail illustrated and described in our issue of Nov. 15, 1890, and an article on "Street Railway Track" in our issue of Dec. 20, 1890, contains much information as to the shape of rails for street railways. Our correspondent considers that the rail should be adapted to the tracking of ordinary vehicles, but on the other hand it is claimed that this is not desirable where the municipal authorities provide a proper paving for the roadway. The girder form of rail is very extensively used, but there are many advantages in tracks in which the head or wearing part of the rail is removable, as in several systems of track now in use.—Ed.)

LAYING ASPHALT ON A WOOD FOUNDATION.

Sir: Engineering News of Feb. 6, in its description and plans of the Ogden Ave. viaduct, does not make it clear as to the use of the asphalt pavement on 6 ins. of pine. Was this used in the construction of the bridge as shown in the plans? Would you advocate the use of a pavement on a highway bridge as shown in the plans illustrated, viz., 2½ ins. of asphalt on 6 ins. of pine laid at right angles to the steel joist?

Yours truly, John J. Dun.

[The drawings of the Ogden Ave. viaduct which were furnished us showed a 2½-in. asphalt pavement on a 6-in. pine floor, as our correspondent states. Before completing the bridge, however, cedar block paving was ordered to be used instead of the asphalt. The floor construction was correctly stated in the description accompanying the drawing (Eng. News, Feb. 6, p. 123), but the correction was received too late to make the change in the drawing.

The question whether the use of asphalt on a wood base would be a desirable construction, we referred to some of the principal manufacturers of asphalt paving, who make the following replies:

Sir: An asphalt pavement requires a foundation which will not yield or bend under traffic. While a wooden foundation has been used, so far as we know, only on two bridges in Boston, yet we are of the opinion that a floor of yellow pine timber 6 ins. thick, resting on 12-in. stringers, spaced 3 ft. 6 in. apart, would afford the necessary stiffness, and an asphalt pavement could be laid upon it with entire safety. As to the durability of such a wooden foundation, we are unable to express any opinion, from lack of experience covering a sufficient length of time. We think that the best and safest form of pavement for bridges is that adopted on the Washington bridge over the Harlem River, and specified for the new McComb's Dam bridge at 155th St., viz., steel buckle plates, bituminous concrete and asphalt surface.

Yours truly, The Barber Asphalt Paving Co.,
F. V. Greene, President.

New York, March 4, 1892.

Sir: In reply to the question of Mr. John J. Dun, I should say that a layer of 2½-in. compressed rock asphalt powder is simply to be regarded as a wearing surface, and if there be any yielding or expansion of the foundation, this surface would probably crack and break. 6-in. yellow pine, on 12-in. stringers, should be sufficiently solid, still hydraulic cement concrete is always to be preferred, and for bridge work a proper bituminous base is the best. Yours very truly, E. H. Wooton.

New York, March 7, 1892.

We fail to see any advantages which the wood foundation would have over a buckle plate and concrete floor except lightness and cheapness. And if the wooden floor were thick enough to make the use of asphalt on it safe, it seems doubtful whether there would be much saved in weight or cost.—Ed.]

PROPOSED HYDRAULIC SHIELD FOR TUNNELING SOFT GROUND.

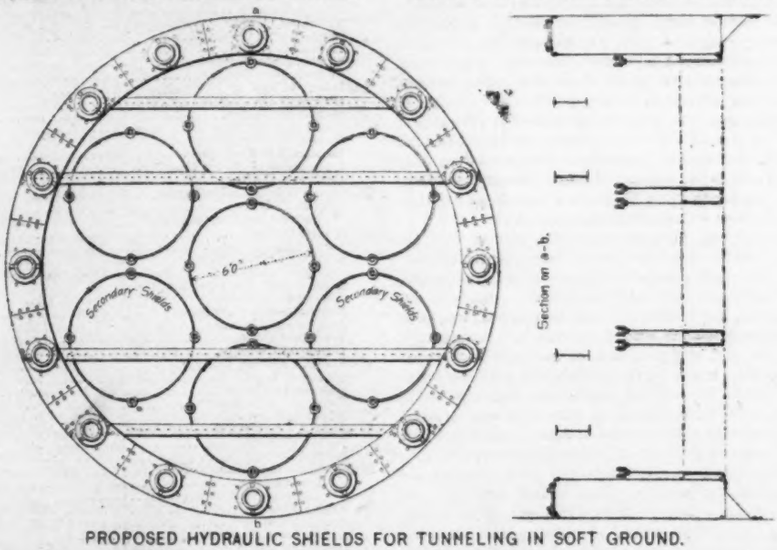
Sir: I send you drawing showing an arrangement of hydraulic shields proposed for tunneling in soft and running ground. The large shield is 20 ft. diam. inside, made in 16 sections. Each section is built as a whole and shipped complete from the shops. The outer skin of each section is one sheet, ¾ in. thick, of the entire length of the shield, the inner skin is of one sheet, ⅛ in. thick. The radial plates are four to each section, two for the sides and two under the rams. They are flanged and riveted to the outer skin and cover plates by countersunk rivets and bolted to the inner skin. The sections are bolted together by bolts through the radial sides. Proper hand holes are made in the inner skin for handling the bolts in assembling the shield.

A ram operates in the middle of the rear of each section. The front of this shield has two shield sheets, properly braced and placed 2 ft. apart, through which the secondary shields operate. The secondary shields are 6 ft. in diameter by 5 ft. long (each), made of one sheet of steel with butt joint and lap plate. These shields may be built

of two parallel sheets, supported by radial stay bolts, as circumstances require. Each shield is operated by four light, double action hydraulic rams; these rams are secured to the I-beams by necessary cross beams (not shown) so arranged as not to obstruct the entrance to the small shields. They will act both for driving forward and for withdrawing the shields. The ends or bearings of the I-beams are riveted under the rams which force the large shield forward, and when pressure is to be thrown on them by the small rams, the large rams are tightened.

In operating this arrangement it is proposed to drive the secondary shields ahead as far as desirable, and excavate all material from them. The space ahead of the shield sheet is now occupied by the small shields (except the small spaces between them), the advance of the large shield (under pressure) can now be effected by withdrawing or not withdrawing the small shields, as may be necessary, to make space for the material ahead. By a proper manipulation of the small shields the most difficult material can be gone through without removing more than desired.

Should it be necessary to use compressed air, covers may be placed on the outside small shields (advanced)



PROPOSED HYDRAULIC SHIELDS FOR TUNNELING IN SOFT GROUND.

and the excavation carried on from the center shield, with such reduced area as the compressors may be able to contend with. Should a bowlder or other hard material be encountered, it can be attacked from the front of the small shields, and so much of it as may be necessary removed.

The advancing lining is built under the protection of the rear projection of the shield, which will never be removed entirely from behind the lining. The space behind the lining, left as the shield moves forward, is ordinarily filled in by settlement. Should it be desired to prevent this and fill this space, I would propose the following plan: Place on the I-beams, close to the intrados of the shield, a sufficient number of injectors operated by compressed air and connected by passages under the rear projection of the shield, which passages open at the extreme edge of this projection. Charge the injectors with grout and, as the shield advances, keep them under pressure and the grout will fill the space left by the shield. Should the shield be working under compressed air, air of greater pressure must be supplied to the injectors.

After the main shield has advanced, the work of advancing the small shields and excavating can go on without interrupting the building of the lining. Plans and dimensions are not insisted on. The object of this communication is to suggest the manner of handling, in detail, difficult material.

Thos. B. Lee.

Greenwood, S. C., Feb. 17, 1892.

[While our correspondent's plan is novel, to the best of our knowledge, we fear that the manipulation of this shield might be very difficult under the circumstances usually attending tunneling of this description.—Ed.]

KITE-SHAPED RACE TRACKS.

Sir: In your issues of Oct. 11, 1890, and Feb. 13, 1892, I see the question of "kite-shaped race tracks" is discussed.

While it is well said so far as that particular problem is concerned, there is a great variety of conditions presented in tracks to suit personal taste, or to fit any given location. In the case of Oct. 11, 1890, it is required to make a track such that one-third shall be in the arc, and one-third in each of the straight stretches, and still leave a definite distance (r) between the center of the judges' stand and the pole ines. Suppose it be required to make that distance = r — 3 ft., or, say, 10 ft. to tangent. A general formula may be deduced as follows:

Let a = angle between the pole line and the center line of track.

Let R = radius of arc.

Let S = straight stretch, and r = distance from center of stand to tangent, then we have:

$$R = S \tan. a + r \qquad (1)$$

$$\frac{R\pi}{180} \times (180 + 2a) = \text{Arc (1,760 or 2,640)}.$$

Substituting value of R in (1), and dividing by 2π, we have:

$$(S. \tan. a + r)(90 + a) = \frac{\text{Arc} \times 57.3}{2}$$

and dividing by S we have:

$$(90 + a)\left(\tan. a + \frac{r}{s}\right) = \frac{\text{Arc} \times 57.3}{2S} \qquad (2)$$

First: If Arc = 2 S in (2) we have:

$$(90 + a)\left(\tan. a + \frac{r}{s}\right) = 57.3. \qquad (3)$$

In equation (3) we have a solution that gives Arc = 2,640 and S = 1,320 ft. respectively, and a = 25°, 55′, 3″ and r = 11 ft.

Second: If Arc = S in (2) we have:

$$(90 + a)\left(\tan. a + \frac{r}{s}\right) = 28.6479, \qquad (4)$$

in which Arc = 1,760 ft., and S = 1,760 ft., and a = 14°, 56′, 11″ and r = 11 ft., and r — 3 = 8, as required by conditions.

The mile may thus be divided into any ratio desired, and values of R — r and S being known, (a) may be found by equation (2).

If R = 572.958, then equation (1) becomes

S. tan. a + r = 572.958 and tan. a = $\frac{572.958 - r}{S}$ (5), which simplifies (S) in the equations (3) and (4) very much.

The value of (a) in equation (5) = 17°, 42′, 28¾″. When S = 1760 and when S = 1320 in equation (5), a = 23°, 3′, 40″.

Thus: The value of (a) in equations (3) and (4) may be readily found when (r) and (S) are known, and if (r) and (S) and (a) are known, then (R) becomes known also. The arc is always known when (S) is given.

In the report for the year 1888 of the "Illinois Society of Engineers and Surveyors," page 71, will be found a general formula for race tracks of the form of the "regulation track," except that it turns in curves of unequal radii.

Thus: L = length of track.

$$R = [57.2958\left(\frac{\frac{1}{4}L - S}{S}\right) + \tan. a\ (90 - a)]\ \frac{S}{180}$$

$$R = [57.2958\left(\frac{\frac{1}{4}L - S}{S}\right) - \tan. a\ (90 + a)]\ \frac{S}{180}$$

When L = 4 S the factor $\frac{\frac{1}{4}L - S}{S} = 1$, and may be omitted.

If any value be given to (a), there will result corresponding values for (R) and (r), which will fill the conditions, so long as (r) is positive in equations (2) and (5) as there shown or in equation for value of (r) as given above.

There are many fine points in these problems which depend on the circle for their solution; a figure that has interested mathematicians for centuries, and in the investigations of its various functions; I have often regretted that the ratio of the diameter and circumference was not integral.

Very truly, D. L. Brandner.

Lincoln, Ill., March 8, 1892.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

I.

The first two students ever graduated as engineers in the United States graduated from the U. S. Military Academy at West Point in 1802, having been admitted to that infant institution in 1800. One of them was from Massachusetts and the other from South Carolina.

For nearly 40 years after this small beginning the only engineering graduates in the United States continued to come from the U. S. Military Academy Finally, in 1840, came the first class (of 13) ever graduated in the United States or in any other English speaking country in civil engineering, who were graduated from the Rensselaer Polytechnic Institute, of Troy, N. Y. From this small and slow beginning has come the present vast development of engineering education in the United States, which, vast as it is, is doubtless little more than a foretaste of what is to come, both in quantity and quality. The quality of the instruction, perhaps, is hardly capable of such further development as to make it accurate or fair to speak of its present stage as "only a beginning," but we may be quite sure that it is not the end, and that hereafter, as heretofore, there will be great advances.

It has appeared to us that a brief comparative and critical review of the rise and progress, and present status, of engineering education in the United States, would be of much interest to engineers at the present time; and that it might possibly have value also, as indicating in some measure the conditions of successful instruction and the direction in which progress is greatest or most needed. The difficulties of such a task are great—so great that we do not propose even to attempt to grapple with some of the most serious of them; but what we do propose to do is this:

1. We shall present as completely as possible the statistical facts as to the rise and progress of engineering schools, collectively and severally. Of some few of the older ones, we may attempt to record what we believe to be the undisputed and indisputable reasons for their success or (comparative) failure; but in general we shall leave that delicate ground alone. A superhuman intelligence would be required to cover it fairly and completely. A far greater knowledge than we can pretend to have or to have sought for, of the determinable and recorded facts, would be required to "cover" it at all. In the main we shall attempt to record only the facts as to the rise and growth of each school, in number of graduates, number of professors and instructors, financial strength, etc.

2. We shall attempt to present with some completeness, in a way to facilitate comparison as much as possible, the present practice of all the engineering schools of much present prominence and importance in regard to requirements for admission, and in regard to the distribution of time amongst the several studies. This, it will be evident, is even a more delicate task than the other. At the best it can only present the quantity of instruction, so to speak. The quality is not indicated at all; and the quality is a vastly more important matter than the quantity. Here we shall most certainly make no attempt to draw conclusions as to particular schools from the recorded facts. The facts themselves will have a sufficient element of possible unfairness about them if it be attempted to draw conclusions in regard to the comparative merits or thoroughness of different schools from the bare records of hours devoted to particular studies or classes of studies. It would be as absurd and unfair to do this as to attempt to draw conclusions as to the comparative mental capacities of men by measuring their skulls.

Nevertheless, measurements of skulls have their interest and their value, and if too broad conclusions be not drawn from them, they are even a rude index of comparative mental powers and mental development. In the same way, and to a much greater degree, we trust that the measurements of the past and present of engineering education, which we have to present, will have their interest and value.

To furnish the necessary basis of fact for this inquiry we procured from the Bureau of Education, about a year ago, a list of what they regarded or classed as engineering schools, numbering 101 in all.

We then sent to each one of these schools a list of inquiries covering six foolscap sheets in all, and to answer which certainly laid a severe tax on their good nature. Nevertheless, we received nearly complete replies to these inquiries from most of the schools on the list, and courteous replies of some kind from all, some newly established and (as yet) insignificant schools excepted. From only one school (unfortunately one of the most important ones) did we receive a positive refusal to furnish any of the information, on the ground that the game was not worth the candle, and the more important facts in regard to that school we have made shift to ascertain in other ways.

The unavoidable difficulties which surround such an inquiry will perhaps best be illustrated, however, by stating that one of the most serious obstacles to it is met at the very threshold of the inquiry, namely, What is an engineering school, and how many of them are there in the United States?

This question at least, one would think, might be easily answered by a very little inquiry. On the contrary, it is one which at the present time is absolutely incapable of exact answer by any amount of inquiry. The reports of the Bureau of Education shed no light whatever on this question; on the contrary, they are an added source of confusion. Thus, on p. 1150 of the last report of the Bureau of Education, which covers the college year 1888-9, there appears a list of 32 "schools of science endowed by the National Land Grant," and on p. 1155 a similar list of 31* "Schools of Science not endowed with the National Land Grant." It is a natural inference that the schools "endowed" plus the schools "not endowed" in a particular way stated will be equal to all the schools of science, in which case we should have only 63 "schools of science" in the United States. But so far is this from being true that, there are some 240 such schools, and whereas we find that there are 94 schools of engineering properly so called, only 32 of them appear in these two lists of 63 "schools of science," the remaining 62 not appearing in either of the lists, which on their face purport to be complete. In detail these two lists stand as follows:

	Listed as eng. schools.	Not so listed.	Total.
Land grant "schools of science"	19	13	32
Non-land grant " "	13	18	31
Totals	32	31	63

Again, turning ahead to p. 1209 of the same report we find a long table of "Degrees conferred by Colleges and Scientific Schools in 1888-9" (the last year as to which the Bureau has enlightened the world). This table reports separately 26 different kinds of degrees, 5 of which are in "Letters," 8 in "Science," 4 in "Philosophy," 2 in "Art," 2 in "Theology," 3 in "Medicine" and 2 in "Law," besides which nearly as many more "scattering" forms of degrees are reported in foot notes. Here at least we should expect to find all of the live and active schools of engineering enumerated among the schools of science. But this is by no means the case. We do indeed find from this list that 216 different colleges conferred no less than 1,616 degrees in science during the year 1888-9. But on investigating even this list we find that it only includes 75 of the 94 colleges which we know to be, and class as, schools of engineering, the remaining 141 not being such as yet, in any proper sense of the term.

The degrees in science conferred by these 216 "schools of science" were divided as follows:

	In course.	Honorary.
B. S. (Bachelor of Science)	1,144	1
M. S. (Master of Science) (!)	125	12
B. C. E. or C. E.	184	..
B. Agr. (Bachelor of Agriculture)	4	..
B. M. E. or M. E.	146	..
Total	1,603	13

Included in these totals somewhere are 4 "A. M. B." (whatever they are; they hail from Tuft's College), 4 Sc. D., 1 Topographical Engineer (from the University of Missouri), 2 Sanitary Engineers (from Columbia) and 8 (only) Engineers of Mines, from Lehigh and Ohio State University.

Of the total of 1,616 scientific degrees thus conferred there were:

From 75 colleges, regarded and listed hereafter as schools of engineering (4 of which conferred no degrees in science in 1889)	993
From 141 colleges, not regarded or listed as schools of engineering (7 of which conferred no degrees in science in 1889)	623
Average number graduates in science in 1889 of the schools listed as engineering schools	13¼
Average number graduates in science in 1889 from the schools of science not listed as engineering schools	4½

Not all, nor even half, of these graduates in science, even from the schools listed as engineering schools, were graduates from an engineering course, or intended to become engineers, as will shortly appear more clearly.

Among the 19 colleges which we list as schools of engineering, and which yet do not appear in this list (and several of them not in any one of these three official lists of schools of science) are some of the more important of such schools, sending out yearly a good many graduates.

From these facts it will be seen how hard it is even to make an approximately correct list of the names of the schools which regard themselves as schools of engineering, or aim to become such. To make an absolutely correct list of those which really are schools of engineering by any standard would be a still harder task. If so fundamental and so apparently simple a task as this cannot be completely discharged, how much less can the quality of the instruction be gaged from any paper returns, and a just balance be struck between the quality of the instruction in the several colleges? We repeat that we should not even attempt nor approach such a task, but content ourselves with recording only such facts as are capable of paper record, leaving to every reader to draw his further inferences for himself, with or without further inquiry.

We subjoin hereto a complete list of the 141 schools, which reported to the Bureau of Education that they had conferred degrees in science in 1889, and hence are potentially or actually schools of engineering, but which, for various reasons, we have not classed as such, and from which, consequently, we have not either asked or received further information. Some of their 623 yearly graduates, beyond doubt, do become engineers. Some of them are as fairly to be classed as schools of engineering as the schools which we do so class. Many of them may become hereafter, if they are not now, first rate schools of engineering, and all of them possibly are aiming in that direction more or less earnestly. In no invidious spirit, therefore, but simply as giving the best attainable record of existing facts, we subjoin the following list of schools which are potentially included within the scope of our inquiry, but which are not yet schools of engineering in the proper sense of the term, so far as we know, and which we shall not therefore again refer to in this series of articles.

List of Colleges reported by the Bureau of Education as conferring Degrees in Science, in the year 1889, but not hereinafter regarded or listed as Schools of Engineering.

[Some of these schools, as elsewhere noted, may actually be schools of engineering in as full a sense as some of those listed as such, but our information does not warrant us in so regarding them. Many of them will doubtless develop into true schools of engineering.]

	Number graduates in science in 1889.
Vermont. Middlebury College	2
Norwich University	7
Massachusetts. Agricultural College	14
Connecticut. Wesleyan University	3
Storrs Agricultural College	0
New York. St. Lawrence University	9
Hobart College	5
Manhattan College	5
College of City of New York (not the University of the City of New York)	26
University of Rochester	5
Pennsylvania. Lebanon Valley College	2
Dickinson College	2
Ursinus College	3
Pennsylvania College	4
Grove City College	15
Bucknell University	3
Allegheny College	1
Central Pennsylvania College	2
Westminster College	13
Pennsylvania State College	15
Villanova College	3
Washington and Jefferson College	1
Maryland. Agricultural College	4
District of Columbia. Deaf Mute College	2
North Carolina. Davidson College	1
Rutherford College	2
Wake Forest College	5
South Carolina. Erskine College	4
Furman University	1
Georgia. Mercer University	2
Emory College	2
North Georgia, Southwest Georgia, West Georgia, Middle Georgia — Agricultural and Mechanical College	0
Alabama. Southern University	3
Spring Hill College	7
Mississippi. University of Mississippi	6
Alcorn Agricultural & Mechanical College	9
Louisiana. State University and A. and M. College	6
Keachie College	1
Straight University	9
Tulane University of Louisiana	4
Tennessee. Grant Memorial University	8
King College	1
Hiwassee College	1
Cumberland University	6
Bethel College	8
Milligan College	3
Kentucky. Berea College	1
Eminence College	2
Georgetown College	3
Central University	5
Bethel College	1
St. Mary's College	1
Agricultural and Mechanical College	4
Arkansas. College of Arkansas	1
Little Rock University	3
Philander Smith College	2
Texas. Fort Worth University	1
Southwestern University	11
Ohio. Ashland University	2
Buchtel College	4
Mt. Union College	6
German Wallace College	2
Calvin College	1
Ohio Wesleyan University	7
Denison University	6
Hiram College	2
Franklin College	1
Muskingum College	3
Heidelberg College	3
Wilberforce College	3
Wilmington College	2
Indiana. Franklin College	6
De Pauw University	10
Hanover College	9
Hartsville College	9
Butler University	3
Moores Hill College	7
University of Notre Dame	5
Earlham College	6
Illinois. Wesleyan University	9
Eureka College	1
Northwestern University	3
Ewing College	1
Knox College	28
Lombard University	10
Illinois College	4
Lake Forest University	2
McKendree College	8
Northwestern College	4
Augustana College	2
Westfield College	2
Wheaton College	2
Michigan. Adrian College	4
Albion College	3
Hillsdale College	1
Kalamazoo College	1
Olivet College	6
Wisconsin. Lawrence University	8
Milton College	4
Racine College	7
Minnesota. Hamline College	5
Carlton College	2
Iowa. Cremourne College	1
Amity College	1
Parsons College	7
Upper Iowa University	2
Iowa College	4
Lenox College	6
Simpson College	3
Iowa Wesleyan University	3
Penn College	2
Central University of Iowa	1
Western College	4
Missouri. Avalon College	7
S. W. Baptist College	1
Christian University	2
Grand River College	10
Westminster College	9
Pritchett School Institute	4
Drury College	3
Tarkio College	5
Central Wesleyan College	2
Nebraska. Bellevue College	2
Doane College	2
Kansas. Baker University	6
Emporia College	1
South Dakota. Dakota University (Mitchell)	3
University of Dakota (Vermillion)	1
Yankton College	1
Montana. College of Montana	2
Colorado. University of Denver	6
California. University of the Pacific	11
St. Ignatius College	4
Santa Clara College	11
San Joaquin Valley College	3
Hesperian College	6
University of Southern California	0
Washington. University of Washington	1

[If the name of any school of science which claims to be also a school of engineering does not appear either in the list above or in the list of schools of engineering which will appear in our next issue, we shall be obliged for information in regard to it, in order that our list of the names of engineering schools, at least, may be made complete.]

*Nominally the list is for 32 schools, but one of these is listed twice for two separate scientific departments.

A gas exhibition building, 150 by 300 ft. in size, is to be erected at the World's Columbian Exposition for the display of appliances for gas lighting, heating, cooking and ventilating, gas engines, processes of gas manufacture, etc. The funds for the erection of the building are to be raised by contributions from the gas companies and manufacturers of gas supplies.

A steel casting, weighing when shipped, 15,557 lbs., has recently been made by the Midvale Steel Co. for the box slide of a 12-in. turret mount for the U. S. S. "Puritan." The actual tests of the steel as compared with the Government specifications were as follows:

	Gov. specifications.	Actual test.
Tensile strength per sq. in.	65,000 lbs.	65,174 lbs.
Elastic limit	25,000 "	31,058 "
Extension	15 per cent.	25.10 per cent.
Contraction	25 "	35.04 "

A NEW METHOD OF LAYING LARGE SUBMERGED WATER MAINS.

The time and money consumed in laying large intake pipes or driving intake tunnels for water-works are great drawbacks in all efforts to meet the demands of our cities for adequate and pure supplies of water. A system designed to remove or minimize these drawbacks has recently been devised by Mr. Robert Powell, Superintendent of the Powell Wire Nail Machine Co., of Cleveland, O.

The city of Cleveland proposes to extend its present intake tunnel 2½ miles, the present intake crib being nearly two miles from shore. Mr. Powell has offered to substitute in place of the proposed brick lined tunnel a steel pipe 8½ ft. in diameter, to be riveted together in sections, towed to place and the sections fastened together by means of flanged and bolted joints, the whole extension, it appears, to be sunk at once to the natural bottom of the lake. This method of laying pipe, it is claimed, can be used for any size or length desired, and would effect, it is further claimed, a great saving of time and expense.

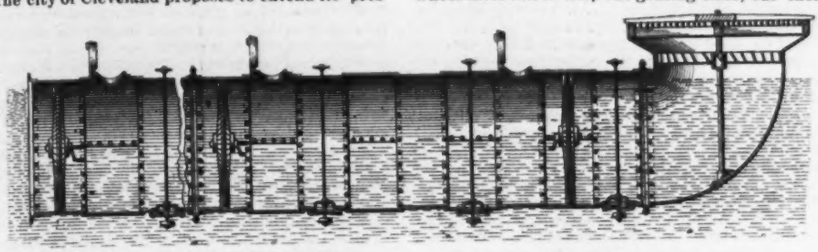
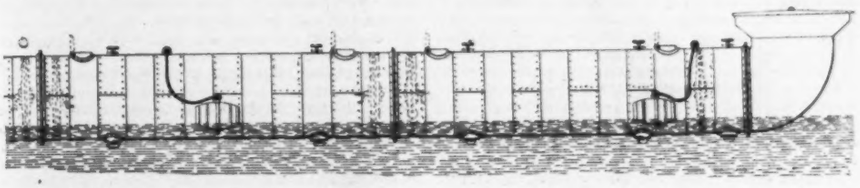


FIG. 1. POWELL SUBMERGED STEEL PIPE. SECTION SHOWING PIPE READY FOR SINKING.



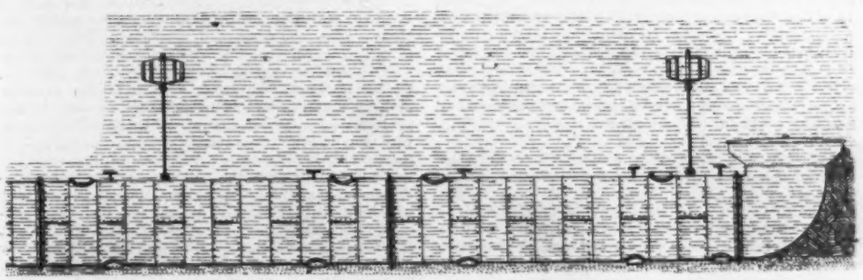


FIG. 2. METHOD OF SINKING PIPE.

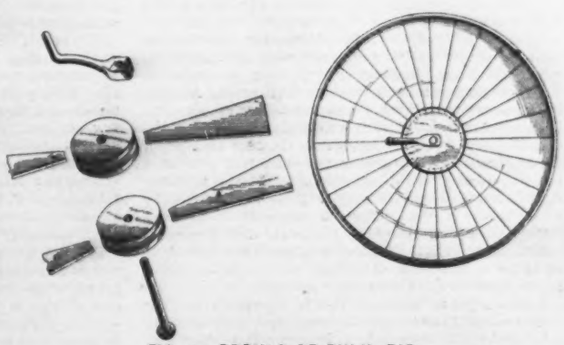


FIG. 3. DETAILS OF BULKHEAD.

The pipe having been riveted together in sections suitable for handling, and bulkheads having been inserted on shore to exclude water, the sections are floated into place by tugs, the flanged joints bolted together and the bulkheads removed, access to the pipe for the latter purpose being had through manholes near each bulkhead. When the whole length of pipe is ready for sinking water is admitted to it through valves in its under side, these being operated by rods extending up through the pipe and provided with hand-wheels at their upper end.

Fig. 1 shows the pipe submerged to the water surface with the valves for admitting water and some of the manholes still open, and with the extreme bulkheads and an intermediate one still in place. Fig. 2 shows the method of keeping the pipe in position while sinking, the casks being designed for this purpose. Figs. 3 and 4 show details of the bulkheads, inlet grating, valves and manholes. Fig. 5 shows the method of turning the pipe to bring the submerged portion above water for bolting.

The bulkheads, as is plainly shown by Figs. 3 and 4, are double and are made to fit tightly by turning the crank nut. Between the outer ends of the staves and the inside of the pipe there is an electric packing to secure tightness.

The device over the grating, shown in Fig. 4, is a wheel intended to keep the grating clear, but there is no explanation of the means by which it is to be made to revolve.

The plan as outlined above is certainly ingenious and seems to contain some practicable features, if, indeed, the whole scheme is not practicable. It presupposes, however, or at least it seems to, that a perfectly calm day be secured and that all the pipe be put together and lowered during that day. The size of the pipe proposed for Cleveland, 8½ ft. in diameter, makes impracticable the handling of any great length of it on the lake bottom, while with water excluded it is evident that a considerable length can be handled at the surface. Connection with the existing intake crib might present some difficulties, but probably these could be overcome.

In Engineering News of May 3, 1890, there was described the laying of an 8-in. steel suction pipe about 1,000 ft. long on the bottom of Lake Champlain, for the water-works at Rouse's Point, N. Y. This pipe was put together on shore, and for each length added the pipe was pushed out into the lake an equal distance, its outer end being plugged to keep out water. When all together the plug was removed, and the pipe sank into place.

At San Francisco two lines of 16-in. flexible seamless wrought-iron pipe were laid for the water company in water from 60 ft. to a very few feet in depth without a current. The pipe was jointed on a scow, and paid out from the rear as each length was added. It took 40 days to do this work.

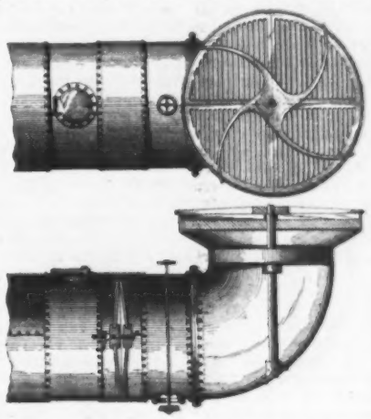


Fig. 4. Plan and Vertical Section of Inlet

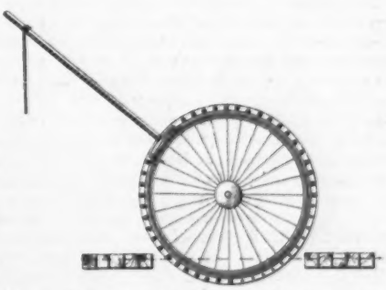


Fig. 5. Mode of Bolting Submerged Part of Pipe

At Vancouver, B. C., about 1,000 ft. of 12-in. cast iron pipe, with flexible joints, was put together on shore in a novel way, and then hauled across the bay by means of cables and stationary engines. In the bay there was a channel 60 ft. deep, and a tidal current stated to be nine miles per hour. A description of the laying of this pipe was given in Engineering News of Feb. 2, 1889.

At Milwaukee, Wis., 36-in. submerged cast iron pipes have been laid, and a double line of 5-ft. cast iron pipe in trenches will be used in connection with the new intake now under construction. The pipe here has been put together in 60-ft. sections on shore, towed to place and sunk, the ends of pipe after sinking being drawn together by clamps and screw bolts, which remain permanently.

The above cases have been cited to show some of the methods, to our knowledge the most notable, heretofore employed in laying submerged pipe. So far as we can learn no attempts have ever been made to join pipe upon the surface of the water, as Mr. Powell proposes to do. There seems to be no reason, however, why this could not be accomplished, provided advantage could be taken of very still water and the work be completed before the surface became rough; and also provided an attempt is not made to fasten together too great a length of pipe.

Mr. John Whitelaw, Superintendent of the Cleveland water-works, has submitted the following report to the Board of Control, according to the Cleveland "Leader" of Feb. 27, 1892:

In your consideration of the question of the adoption of a steel tube or pipe to be laid on the bottom of the lake, as a substitute for a masonry tunnel in an extension of the present water-works tunnels to a distance of 2 1-2 miles beyond the present inlet protection crib, I desire to call attention to the following

facts: The line of the pipe would cross the track of vessels approaching our harbor from the west as well as the anchorage ground of vessels. The sinking of vessels over the pipe, improbable as such an accident may be considered, should not be overlooked. It is said that the pipe is too large to be damaged by anchors, and that may or may not be true, but should nevertheless be considered. The larger class of vessels carry anchors weighing as high as 4,000 lbs., and one of these dropped upon a pipe from a vessel's guard rail, a height of between 50 and 60 ft., would most certainly injure it. Unless the pipe were strengthened between the joints it would sag of its own weight, unless laid in a trench. If not fastened to the bottom of the lake there is danger of the pipe being moved by currents or the action of the water during storms. The clay shale forming the bed of the lake carries a large percentage of sulphur in the form of iron pyrites, and the part of the pipe in contact with the clay would oxidize rapidly. Ice is known to form in ridges frequently reaching to the bottom of the lake, and if this should happen over the pipe, it would be crushed. In the plans that I have seen no provision is made for expansion. There is a difference of about 27 degrees between summer and winter temperature, causing an expansion of nearly 26 ins. in summer over the length in winter, for which provision would have to be made if the plan were adopted. To connect with the two inlets of the present tunnels the rip-rap stone against the east side of the crib as well as the stone in two compartments would have to be removed, while one hole 5 1-2 ft. in diameter would have to be cut through three walls, and one 7 1-2 ft. in diameter through one wall, all of them at the bottom of the structure. These acts would seriously weaken the crib, and endanger the supply of water to the city.

We quote the above to show the nature of the objections urged by the water-works officials against the adoption of the submerged pipe in place of a tunnel. In addition we are informed that a brick lined tunnel is preferred on account of its greater durability, and that Mr. R. H. Herrick, Director of Public Works, is not in favor of the project.

Mr. Powell claims for his submerged pipe that it can be laid much more quickly and at less cost than a tunnel can be driven and lined. If this is true it is a point very greatly in his favor, as our cities are far too apt to wait until more and better water is badly needed before taking steps to secure it, and tunnel work is likely to meet with great delays, as has been the case at Chicago. If practicable, Mr. Powell's plan might prove at least a partial solution to the problem at Chicago, where a better water supply should most assuredly be secured before the World's Columbian Exposition. While the exclusion of sewage from the lake is undoubtedly the only practicable way of securing pure water for Chicago, it is undoubtedly true that extensions of the present intakes, especially those supplying parts of the annexed district, would do much to improve the water.

Whether a submerged pipe so large as 8½ ft. in diameter and 2¼ miles long could be successfully sunk by the plan described above, we will not undertake to say, but it seems very probable that for smaller pipes and perhaps for shorter lengths this method might be used to advantage.

THE TRANSMISSION OF POWER.

Of the papers presented at the Buffalo convention of the National Electric Light Association, that of most general interest was on the subject stated above. The author, Mr. Carl Hering, visited the Frankfort Electrical Exhibition last summer and made a careful examination of the Lauffen-Frankfort transmission plant (described in our issues of Aug. 22 and Oct. 17, 1891). This portion of his paper is therefore of especial interest. His discussion of other systems of power transmission is largely extracted from recent papers by Messrs. Saunders Morris and Coleman Sellers before the Engineers' Club of Philadelphia. It is to be remembered that Mr. Hering, being an electrical engineer, is naturally inclined to make out as good a case as possible for electrical transmission in comparison with other systems. In the main, however, little fault can be found with his conclusions. We reprint the paper practically in full as follows:

Mechanical Methods of Power Transmission.—The most common method of transmitting power is by shafts and belts; but although this is one of the best for very short distances, it need not be considered for anything over a couple of hundred feet. In an electric light station in Rochester there is a belt 175 ft. long and a shaft 200 ft. long, and there are doubtless a few other exceptional cases, but it requires peculiar circumstances to make this practicable for even such a limited distance. Even for short distances, shafts and belts are rapidly being replaced by individual motors, having their power transmitted to them electrically.

The only modification of the shaft and belt system adapted for longer distances is wire rope transmission. This is an old, well exploited system, and its narrow limits are already well known. The poor efficiency, the liability to stoppages and the great increase of cost with distance, are very much against it for long distances. The fact that it takes a 2-in. rope running at a speed of 2,000 ft. per minute, to transmit only 35 HP. is sufficient to show the impractibility of this system for long distances or large powers. A significant fact is that in Switzerland, where this system is perhaps more used than anywhere else, it is being rapidly replaced by electrical transmission. Another fact which is significant is, as I am informed, that rope transmission is not being considered at all by the promoters of the great Niagara Falls plant.

Fluid and Fuel Methods of Transmission.—Transmission by water direct is limited to locations which are peculiarly favorable and is not general enough to be considered here. In Zurich there is a high pressure reservoir located on a neighboring mountain, the water from which is used for power purposes in the city. There are doubtless other similar cases, but they are all limited to peculiarly favorable locations, as well as to comparatively short distances. Even in Zurich they are now installing an electrical plant from which power is to be distributed. [The distribution of power by hydraulic pressure is much more generally used than Mr. Hering implies. A large proportion of city water-works furnish water for running elevators, small motors, etc. We may also instance the high pressure hydraulic distribution plants of Birmingham and some other English towns.—Ed.]

Transmission by steam is of more general application, but the expense of the piping, the attention it requires, and the loss in the condensation, all limit its practicability to within a comparatively small radius, probably well within a mile at the most. It is in successful use in the city of New York, but its introduction does not appear to be making very rapid progress.

Transmission by gas as a fuel is in successful operation for very long distances over 100 miles, but it is limited to localities where natural gas is found and its supply is, I am told, very uncertain.

Transmission by compressed air is perhaps the chief rival of electrical transmission, with which it shares many advantages over all the others. It is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. In Paris there is a large central station for the distribution of compressed air, and it seems to be in successful operation. [The Popp system. See Eng. News, Dec. 14-28, 1889.—Ed.]

It does not appear, however, that the advantages over electrical transmission are so great that it will not soon be replaced by electricity. Its introduction is not making the rapid strides that the introduction of electrical transmission is already making. Its efficiency as compared with electricity will be shown very well at the Niagara Falls power plant, where a compressed air system is to be introduced in competition with electricity. One of the disadvantages for power purposes is the fact that when the compressed air expands in the engines it generates cold to such an extent as to seriously affect the working and the lubrication of the engine. [This has been found an advantage in Paris, where the exhaust air is used for refrigerating purposes.—Ed.] It appears that fires must sometimes be built to heat the air before it can be used at all in the engines; the advantages over a boiler and a steam engine are thereby greatly reduced.

From a paper of Professor Unwin it appears that the transmission of power by compressed air is practicable to a distance of at least 20 miles. It seems that 10,000 HP. can be transmitted to a distance of 20 miles in a 30-in. main at 132.3 lbs. per sq. in. pressure, with a loss of pressure of only 12%. The efficiency of such a plant is said to be 40% to 50%, if the air used is cold, and 50% to 75% if the air is reheated.

Mr. Coleman Sellers, one of the Niagara Falls Co.'s advisory committee, states in a recent paper that experiments were tried by Mr. Wm. L. Saunders, of New York, of heating the compressed air at the receiving end by combustion within the mains; the result, he states, leaves little to be desired, as the product of the combustion is added to the quantity of compressed air, while the heated air and gas also increases the efficiency.

Efficiency in Per Cent.

Distance in miles.	Hydraulic.	Pneumatic.	Wire rope.
½	50	55	91
1	49	54	85
3	41	51	61
5	37	50	43
10	26	43	21
13	18	39	11

A very good idea of the relative efficiencies of several of these systems may be obtained from the foregoing table by Beringer, giving the efficiencies for different distances.

The most usual and extended method of transmitting power, if it may be so called, is that of transporting the coal itself from the mines to the manufacturing cities. Although this is the system which is used most extensively by far, the objections to it are such as to offer great inducements to other competing systems. Even in Philadelphia, which is not far from the coal regions, the price of a ton of coal is said to be doubled by the cost of its transportation from the mines to the boilers in the city. In engineering terms this means an efficiency of only 50% in the transmission. An electrical system with such a poor efficiency in the line would scarcely be considered for a moment, and yet, strange to say, we are still transporting most of our power on the railroads in the form of coal and utilizing it in small individual boilers and engines, the efficiency of which is so low that even an amateur electric motor builder would be ashamed of his motors if they did not give a better efficiency.

It will be seen, therefore, that with the exception of compressed air and the railroads, the field is quite clear from rivals for electrical transmission, and that most of the disadvantages attending other systems do not apply to electrical transmission. Even in the two excepted cases there are many advantages in favor of electricity, and it is probably only a question of time when they too will be replaced by electricity. Perhaps the most serious objection to electrical transmission is that it is new, an objection which is often a much more serious one to overcome than many engineering difficulties. If capitalists were all engineers and were not hampered by prejudices against new departures merely because they are new, what enormous strides engineering would make.

Systems of Electrical Transmission.—Coming now to electrical transmission, let us see which of the various methods stand chance of success for long distances. To be successful at all for long distances requires, beyond question, the use of very high potentials, as otherwise the cost of the line will make it impracticable. If continuous currents are to be used, they must be generated directly by the dynamo at that high potential, as there is no means at present known for converting a low tension continuous current into one of high tension without the use of moving machinery; continuous currents would therefore require that very high tension currents be produced directly from a dynamo with a commutator. Long experience and frequent attempts have shown that it is not practicable to exceed five or six thousand volts at the very most on continuous current dynamos, and even then there are many objections. As this would be a comparatively low voltage for long distance transmission, continuous current systems stand very little chance of being used for more than comparatively short distances. Another disadvantage is that the motors also must be run at this high potential, unless the current be transformed by a motor dynamo, which is awkward and expensive, as it involves the use of moving machinery requiring attendance. The starting of a motor at such high potentials also introduces difficulties. A point in favor of continuous currents is in the fact that the line is not charged and discharged continuously.

The field is therefore left tolerably clear for alternating currents, first because alternating current dynamos require no commutator; second, because such currents may readily be converted from a low tension to high tension and the reverse with but with a small loss of a few per cent. in each transformation. An alternating current dynamo for generating low potential currents is the simplest kind of a dynamo, and a transformer requiring no moving machinery is a very simple thing to take care of, if, indeed, it requires any attention at all. Simplicity alone, therefore, is very much in favor of alternating currents.

The only serious objection to the use of simple alternating currents for the transmission of power is that they are not so suitable for running motors as direct currents are. There is a class of motors called synchronous motors, which are, as a rule, simple alternating current dynamos used as motors, as in the case of direct currents. These must be run at a speed which must synchronize with that of the dynamo as precisely as if coupled to the shaft of the dynamo. They run very well after they are started, but many of them come to a dead stop if overloaded sufficiently to retard their speed below that of synchronism, even if retarded only to a slight amount.

Their chief fault, however, is that they cannot be started readily; furthermore all the load must be taken off before they can be started at all. Various methods are used to start them; but although they accomplish the object, they can hardly be termed satisfactory solutions of the problem, at least as far as they have come to my notice. This makes them unfit for many purposes, as elevators, street cars, shops, etc. When there is only one large dynamo, which is started, say only twice a day, it can be done by a small inefficient motor or by starting both the generator and motor together, or by some other similar means, but when it concerns the distribution of power as distinguished from mere transmission, this disadvantage becomes of great importance.

But this objection may not continue to exist very long, because with the amount of attention given this subject

at present, it is not unlikely that some solution will be found before long, if it has not been found already. Several methods have already been devised for overcoming it, one of which was shown in the Frankfort transmission. Others are being at present worked out, among which may be mentioned that of Mr. Stanicy and others; also that of Leblanc, which, I understand, is being experimented with on a large scale in the interests of the Rothschilds, of Paris. It is therefore likely that before very long this problem also will be solved by several methods so as to leave very few objections to the use of alternating currents.

There are in general two methods for transmitting to great distances by alternating currents. One is to generate the high tension currents directly at the dynamo; this is the system used at the Ferranti station in Deptford, London. At the distant end these currents are then transformed to low tension currents suitable for distribution to consumers. The second system is, to generate low tension currents at the dynamo, then to transform these at the dynamo station into high tension currents by means of transformers, which high tension currents are then sent through the line to the distant station, where they are transformed a second time back to low tension currents; this is the method which was used at Frankfort.

The advantages of the former is that there is only one transformation, but a disadvantage which appears to outweigh the objection to an additional transformation is that the high tension current must be generated on moving machinery and that it must be controlled by switches and other apparatus, which must be handled by the attendants. The dynamo and switches are thereby rendered very much more complicated, and, as they must be handled, there is a constant source of danger to the workmen. This source of danger and the complications are overcome almost entirely by the second system. In the one used at Frankfort the dynamo was the ideal of simplicity in its construction, and the high tension circuit contained, with one exception, no switches or any apparatus whatsoever that required to be handled.

To recapitulate, it appears probable that the solution of the problem of long distance transmission will be solved by the use of high tension alternating currents originally generated at a low voltage, then transformed to a high voltage, then sent over the line and finally transformed back to a low voltage; this will furthermore be done by some system which will enable motors to be used on the circuit. The system exhibited at Frankfort was such a one and it appears to have been a perfect success in every way. It seems therefore that the problem has not only been solved, but also demonstrated by a practical illustration on quite a large scale.

Electric Power Transmission in the United States.—Among the transmission of power plants in this country may be mentioned the following: Dalmatia mine, California, about 100 HP. transmitted about 1¼ miles at 1,800 volts by direct current; Virginia City, Nev., about 300-HP. transmitted about ½ mile, with an efficiency of 70%; Calumet & Hecla mines, 400 HP. transmitted about 1½ miles at about 1,000 volts; efficiency, 73%. These are all direct current systems (Brush). Another was installed by the Westinghouse Co. at Telluride, Colo., in which about 120 HP. are transmitted 2¾ miles at 3,000 volts, and at a commercial efficiency of 75%. This is of special interest, because it is an alternating current plant, in which the motor and dynamo must run synchronously. The difficulty of starting the motor is overcome by the aid of a small motor of 10 HP. which is first run to bring the large one up to speed, after which it will remain in synchronism with the generator. The cost of this plant, exclusive of erection and line, is said to have been $10,000, or about $100 per horse power delivered.

A fair idea of the cost of transmission of power plants abroad may be obtained from the following table of figures given by the Oerlikon Co., and taken from plants actually installed by them, mostly in and about Switzerland. The table is copied from a paper read by Mr. Saunders Morris at the Engineers' Club of Philadelphia.

Distance, miles.	HP. delivered.	Cost of Generators.	Motors.	Line.	Total (a)	Per HP. delivered.
6.25	11	$647	$540	$2,350	$4,700	$442.60
.43	510	.....	.....	.....	43,250	65.30
3.75	220	5,190	4,700	3,135	14,500	96.20
1.50	150	3,720	3,525	1,615	10,120	67.30
.56	71	2,155	1,900	294	5,100	71.60
1.87	85	3,135	2,741	2,155	9,220	108.50
2.20	51	1,761	1,567	1,469	5,505	109.40
5.00	41	1,174	980	1,682	5,000	121.10

(a) This includes regulating apparatus, instruments, poles, insulators, lightning arresters, erection and supervision.

The Lauffen-Frankfort Transmission Plant.—This experimental plant was erected by the joint co-operation of the Allgemeine Elektricitaets Gesellschaft, of Berlin, and the Oerlikon Co., of Zurich, the chief engineering features being due to their respective engineers, Mr. Dobrowolsky and Mr. Brown.

The main object of this plant was two-fold, first, to test and demonstrate to the public the feasibility of using very high tension alternating currents on bare overhead lines; secondly, to show the practicability of a modified alternating system especially adapted for running motors. The former feature was due to Mr. Brown and the latter to Mr. Dobrowolsky. It was an experiment in so far as it was at first not known whether such very high potential currents used on overhead lines would develop any new and grave difficulties, which were predicted by some mathematical electricians, involving capacity and induction effects. These fears were not realized, however, or, in the terse language of Mr. Dobrowolsky, "the losses in the line all followed Ohm's law."

The experiment demonstrated that with the use of carefully made and proportioned porcelain insulators containing oil, such high potentials can be used successfully on bare overhead lines. Strange as it may seem, one of the unexpected serious difficulties experienced on a line with similar insulators was that such large white insulators formed tempting targets for the small boys to throw stones at, because a "good shot" from one of the little rascals was rewarded by the pleasure of seeing the insulator flying to pieces or ringing like a bell.

The plant consisted in general of a dynamo of exceedingly simple construction, generating a large current but of only 50 volts. This was led through the switchboard with all its accessory apparatus, and was then transformed by a step-up transformer into a small current of 15,000 volts. This was led through bare overhead wires a distance of 108 miles, where it was again transformed to a low voltage by step-down transformers.

It should be noticed that the currents at the dynamo and switchboard, where they had to be handled, were only 50-volt currents, thereby avoiding all possible danger to the attendant besides facilitating greatly the construction of the dynamo. In this feature it differed characteristically from the system used by Ferranti in London, in which the dynamo and switchboard are in the high potential circuit, the dynamo generating the high voltage directly. The Frankfort system was furthermore grounded in such a way that even in the case of a cross with the high tension circuit, the voltage at the dynamo or switchboard could never exceed 50 volts above the ground. The second feature of this plant was, that it enabled motors to be run with the same and even greater ease than continuous current motors. It therefore solved the problem of distribution as well as of transmission of power.

It should be clearly understood that it was to solve the motor problem that a certain modified alternating current system, known as the three phase system, was used. This system involves the use of three wires throughout in place of two; but it not only overcomes the difficulty of the distribution of power and the starting of motors, but it goes farther, because such motors are very much easier to run and are simpler in construction than the best continuous current motors, a feature which counterbalances to a great extent the objection to the use of three wires.

Time will not permit a detailed discussion of this three phase system here; it will suffice to say that it consists of three simple alternating currents—one in each wire—the waves or impulses in the three wires following each other in succession similarly to the relative motions of the three cranks of a three cylinder steam engine or the pistons of a three plunger pump. Such a set of currents produces a rotating magnetic field, while the simple alternating current produces merely an oscillating field.

The rotating field furthermore has a definite direction of rotation. It is this feature of a rotating magnetic field as distinguished from an oscillating one which renders it particularly well adapted to run motors. The ordinary simple alternating current motor may be said to be analogous to a steam engine with one crank, having its slide valve operated by an independent rapidly running engine; it has a dead point from which it will not start, but after it is up to speed it will run very steadily. The rotating field motor, on the other hand, is analogous to a three-crank engine operating its own valves. There is no dead point, and it can start itself, even with full load.

The small town of Lauffen is situated on the river Neckar, in the mountains, 108.6 miles south of Frankfort, and not far from the city of Heidelberg. There is a large water power there, 300 HP. of which is to be transmitted electrically to the manufacturing town of Heilbron at 5,000 volts by this system. The turbine and dynamo of this plant were loaned for the Frankfort experiment. The turbine is horizontal, has a speed of 50 revs., and can develop 300 HP. It drives a single dynamo by bevel gears.

The dynamo is of exceedingly simple mechanical construction, has a speed of only 150 revs., and is capable of generating three alternating currents of 50 volts above their common connection, and about 1,400 amperes each, or a total of about 200 kilowatts. The number of alternations is 40, which is purposely made very low. This current passes through the switchboard and regulating apparatus to a three core transformer of equal capacity. The ratio being 100, it is transformed up to about 12,500 to 15,000 volts, measured between any two of the three wires, and down to 4 or 5 amperes. By connecting two of these with their primaries in multiple, and their secondaries in series, they will generate 25,000 to 30,000 volts.

An interesting feature about this system is that although the three currents have different phases, they need no separate return leads, because the nature of the currents is such that each acts as a return current for the other two in multiple arc. The three circuits are therefore merely connected together to a common terminal, after they have passed through the dynamos, transformers and lamps. This terminal we will call the neutral point. This neutral point was grounded throughout the system, in the low tension as well as in the high tension circuits, and at both ends of the line. No current, however, will flow through the ground when the plant is working normally.

The line consists of three bare, hard drawn copper wires, 4 mm. (0.157 in.) in diameter (slightly less than No. 6 B. & S. gage), having a resistance of about 2 ohms per mile. The distance being 108.6 miles, the resistance of each wire is about 217 ohms, which, with 5 amperes, makes a loss of about 1,000 volts on each of the three lines. The lines were run on poles with one cross arm 16 ft. above the ground, the wires being one meter from one another. There were 3,227 poles, at 200 ft. spans; each pole had a skull and crossbones painted on it to indicate the sure fate of any one who could not keep his hands off. There were 3,000 large porcelain insulators, 8 ins. in diameter, made in two parts and with three oil grooves, and 6,500 small ones, made in one piece and with one oil groove.

The only apparatus connected with the high tension circuit was the fuse wire and a short-circuiting device to replace the switches for opening the circuit. The fuses for each of the three lines consisted of two copper wires in parallel, each 0.15 mm. in diameter (between Nos. 34 and 35 B. & S. gage) and 2 meters in length. They were stretched between two poles outside of the building. They were exploded (one can hardly employ the term "blown"), several times to test their effectiveness. Even to an electrician it seems strange to think of several hundred horse power being transmitted through a few wires about the size of a hair!

The short-circuiting devices consisted of pieces of bare wire shaped like a V inverted, suspended directly over the line wires. These were placed at very frequent intervals along the line. In case of any danger or interruption, or in case the line must be handled, this wire is lowered by a string, and drops on the line wires, thereby short-circuiting the line, which blows the fuse and opens the circuit. This is a very cheap and effective substitute for a switch, which would be dangerous to handle in a 30,000-volt circuit; furthermore, there is absolutely no possibility of a current being on the line when this device is down.

Both the high tension and low tension circuits were carefully grounded at both ends at the neutral point, that is, at the common junction of the three wires. This makes the system perfectly safe, for in no case can the voltage on the low tension circuit be greater than the normal low voltage. In case of a ground on the line, or a cross between the high and the low tension circuit, the fuses will blow.

Arriving at the receiving end, at the exhibition at Frankfort, the high-tension current was transformed down to about 75 volts, measured between any two of the three wires. Some of it was used to illuminate 1,000 16 c. p. lamps on the exhibition grounds, consuming 58,000 watts, and some were used to run a 100-HP. motor, which drove a centrifugal pump, the water from which formed an attractive waterfall on the exhibition grounds. The average voltage used on the line was about 16,000 volts, and the greatest amount of power, I am told, was about 180 HP. This was not because of lack of ability to transmit more, but merely because that was the full capacity of the bank of lamps and the motor.

The official tests are not yet completed, but from careful commercial measurements it was found that the efficiency from the dynamo current at Lauffen to the lamps at Frankfort was 72%, when about 80 HP. was transmitted, which is very satisfactory. It is furthermore probable that accurate measurements will increase rather than decrease this figure. It should be noticed that this was the efficiency for only 80 HP. From this efficiency must be deducted the loss in the generator and that in the motor in order to get the total.

After the Exhibition closed the plant was also run at 30,000 volts. During that test one of the insulators failed. The plant was run in all kinds of weather without apparently any appreciable increase of the loss on the line. It was furthermore found that the predicted heavy losses, due to the condenser action, did not exist, and that for practical purposes these losses follow Ohm's law. It will be remembered that this was one of the uncertain features, the existence or non-existence of which this experiment was to prove. As the distance was far beyond that at which power will, in practice, be carried, say 30 or 40 miles, this experiment demonstrates that such a transmission is entirely feasible at distances met with in practice.

The Oerlikon Co. gives the following figures regarding the cost of the plant: Assuming that 300 HP. is developed at Lauffen, and that all the energy received in Frankfort was converted into light, the cost of the plant per effective horse power, measured at the terminals of the lamp, will be about $292, of which $236 is for the line alone. These figures appear high, but it must not be forgotten that in this particular plant there were conditions which would not be likely to occur in practice—namely, relatively small power on the one hand and exceedingly great dis-

tances on the other, both of which factors naturally increase the cost per horse power.

It may be of interest to add here that Mr. Dobrowolsky, of the Berlin firm, states that he would be willing to bid on the contract to transmit 1,000 or 5,000 HP. from Niagara to Chicago, a distance of about 500 miles. He proposes to use 40,000 or 50,000 volts and claims that an efficiency of 60 to 75% could be obtained without difficulty.

At the close of his paper Mr. Hering stated that the Oerlikon Co., of Zurich, had made the following proposal for the transmission of power from Niagara Falls to Buffalo: The three phase alternating current will be used as in the Lauffen-Frankfort transmission, but it will have 50 alternations instead of 40, the larger figure being the lowest at which arc lamps will run satisfactorily. The size of the turbines at Niagara Falls has been fixed at 5,000 HP. each, and the speed at 250 revolutions per minute. These turbines are to be set at the bottom of a shaft and will work under a head of about 140 ft. [See Eng. News, Jan. 23, 1892. p. 76.] A vertical shaft extends from the turbine to the surface, and the armature of the dynamo will be fixed upon this shaft. The armature will be 3.3 meters (10 ft. 10 ins.) in diameter, and the speed of its circumference will be about 8,500 ft. per minute.

This dynamo will generate three alternating currents, each of 2,000 amperes and 600 to 700 volts. The efficiency is to be about 96%, and the dynamo will be kept cool by artificial ventilation. From the dynamo the currents will be led through two step-up transformers in series, producing a potential of 25,000 volts. To build a single transformer of 5,000 HP. to produce this potential was found to be impracticable. The Oerlikon Co. say: "25,000 volts potential is no longer to be looked upon as a venture." The transformers will be artificially ventilated and the high pressure coils will be insulated in oil.

From the power station at Niagara Falls the current will be carried, probably by bare copper wires on poles, to Buffalo, a distance of about 20 miles. The cost of the line is estimated at only $20,000. This line is to terminate at a step-down transformer station where the potential will be reduced to about 1,800 to 2,000 volts. From these stations it is led through the streets as by the systems at present in use, being further reduced in potential by a second set of transformers at the locality where it is to be used. The cost of the electrical part of the proposed plant, including the generators, exciters and transformers at both ends of the line and the line itself, is stated to be about $180,000 for each unit of 5,000 HP. An efficiency of 84% is guaranteed at the low pressure terminals of the secondary transformers. This reduces to $36 per HP. The cost of the line reduces to about $4 per HP., or about 10% of the whole

The discussion on Mr. Hering's paper was opened by Prof. Elihu Thomson, of the Thomson-Houston Electric Co., and several other prominent electricians took part in it. We condense it as follows:

Prof. Thomson thought Mr. Hering's figures on wire rope transmission must refer to straight lines. If many curves or bends must be made in the system the efficiency runs down rapidly. With electrical transmission, however, the carrying wire may be bent as much as desired, with practically no loss. Whether coal will ever be burned in the mining regions, as Mr. Hering suggests, and the power developed there transmitted electrically to the cities depends on the comparative cost of carriage of the coal and conveyance of the electricity. This applies, however, only to coal used to produce power. The use of coal for heating is a different matter, as in heating a large proportion of the total energy of the fuel is utilized.

It is correctly stated that the commutator is the obstacle in the way of applying continuous currents to power transmission. A commutator must be very expensive in construction to endure indefinitely 3,000 volts. It requires very high insulation, very careful construction and very numerous segments.

It has been found impracticable to raise the electrical pressure existing between two adjoining segments on the commutator beyond a certain amount. The current is apt to leap the gap between the segments and form short circuits. Therefore, for high voltages, we need to divide the commutator up into very fine divisions. But that involves dividing the winding also, and it is very difficult to wind such a commutator. The practical limitation to the voltage of continuous current will probably be found somewhere between 2,000 and 3,000 volts. It is also to be remembered that with the direct current at high pressure, difficulties with the commutator occur at every step of the process. We are driven then, as Mr. Hering says, to the use of alternating currents.

This system is also favored by the fact that large size transformers can be built with high efficiency, and that it avoids all danger in handling high tension currents. Difficulties with insulation are overcome by immersing the transformer in a bath of insulating oil.

"I am greatly in favor of the three phase system. The only question to my mind is whether you should take your lines overground or underground." Current of 15,000 to 20,000 volts are, of course certain death to a person coming in contact with them. We are approaching the conditions of lightning, and not simply a single stroke, but great number of strokes following each other in rapid succession. If the wires were underground there would be no need of painting a skull and cross-bones on each pole. On the whole it is well to consider whether the wires should not be put underground in pipes filled with oil. Use throughout the high tension circuit the insulation used on the transformers. For moderate distances the cost of this should not be prohibitory. In this way leakage from wet insulators and interference due to lightning would be avoided.

It is a fact in favor of a high potential system that the liability to damage by lightning is less the higher the potential. In other words the nearer you approach lightning in the operation of your plant, the less liability there will be that lightning will interfere with the plant's operation.

A great advantage of the three phase system is that it can be utilized in so many ways, furnishing lights direct from the mains by converting down to any voltage, and in fact operating any apparatus using either single phase or multi-phase alternating currents. By the use of a "motor-generator," continuous currents of low voltage may be obtained for operating existing street railways or mains adapted for such currents.

Imagine what such a system would do for New York City, for instance. There are now separate plants and stations in the city, here and there, on expensive ground and in expensive buildings. Suppose we go up the Hudson river somewhere and establish a power plant, get our coal very cheaply delivered, get water for condensing the steam in the engines, and get rid of the ashes by making land somewhere. We then simply lay pipes down to the city, a distance of whatever number of miles is convenient, making the pressure what we find is proper for the economy in the transmission. We deliver current, three-phase it may be, to the different stations, simply using motor generators feeding into the existing mains for the present systems. Should we wish to run out new mains with currents transformed down to low pressures, we can do it very easily. In other words, we could satisfy almost every need, even down to the plating current. We can give everybody what is required from such a system.

As to what is the electrical pressure that would limit us in such transmissions as we are talking of—well, there really seems to be no particular limit. It would seem to me practicable, if it were necessary, to raise the pressure to 100,000 volts. It simply means that you have got to have your oil insulator thick enough not to be perforated by 100,000 volts. In some recent experiments I have made, I find that oil is excellently well adapted to stand such pressures; it is even better than solid glass. Where glass breaks down with perfect ease I find the oil stands up, or, if it does break down it reinsulates itself. If there is a puncture through the oil, and a spark flies, it does not necessarily involve the destruction of the plant, as the oil slips in and covers up the defect.

Mr. H. Ward Leonard approved the previous statements as to the difficulty of generating continuous currents of high voltage. At the same time it is true that the commercially available alternating current motor is yet to be put on the market.

For the transmission of power over great distances, the high tension alternating current says: "How easy it would be to get there if somebody could only utilize me." And the low tension continuous current says: "How easy it would be to use me for any application if somebody could only get me there." I claim that the transmission of power over great distances necessitates the use of both the alternating and continuous currents; and that by the combined use of the systems the result is commercial today over any reasonable distance and for the transmission of any amount of power.

Both theoretical and practical considerations demand that energy should be transmitted over the great distances demanded for commercial applications by means of the alternating current and should then be converted into a continuous current in order to best utilize it in the actual performance of all sorts of work. By this plan we shall be able to undertake the transmission of power at any distance and on any scale by apparatus manufactured by half a dozen companies.

Suppose, for example, that we have a water power at a distance of 20 miles from a mine where it is desired to utilize 2,000 HP. for various purposes. Let us start with 10,000 volts and lose 22% in the conductors. The cost of our generator, conductor and synchronous motor will be about $90 per HP. at the point of work. The synchronous motor will drive the necessary continuous current generators of 500 volts and less to supply hoists, pumps, locomotives, ventilating fans, air compressors, lights, etc. If the total power installed be 2,000 HP., the cost of the working motors will be perhaps $50,000. With 2,000 HP. installed, the maximum demand for power will not exceed 1,500 HP., the cost of continuous current generators and conductors for this service will be about $52,500, and the cost of the synchronous transmission system about $135,000. Allowing $42,500 as an average cost for the development of the water power and the construction, we have a total cost of plant of $280,000, or $140 per HP. delivered by the electric motors at the point of work.

Mr. L. B. Stillwell believed that several American firms would be willing to undertake feats in power transmission equal to the Lauffen-Frankfort plant, if given such government backing as the German firms had. In some respects the two phase current is preferable to the three phase. Where more than one motor or where motors and lights are to be run, considerable difficulty has been found in maintaining proper phase relations between the different currents of the three phase system.

The plant at Telluride, referred to by Mr. Hering, has a generator which delivers current at about 3,300 volts potential. This high voltage was chosen in view of the ultimate transmission of the current a distance of 8 miles; the one motor now at work is 2¾ miles from the generator, but it is intended to locate other motors at different mines along the range. The motor is used for running a stamp mill, a work in which varying torque and varying speed are not required. The motor runs 24 hours a day and at least six days in the week. Since the starting of the plant the actual time it has been out of operation on account of trouble in working averages only 16 minutes per day; and about 80% of these delays were due to difficulties in regulating the turbines. If there is a thoroughly reliable turbine regulator on the market, I have not heard of it. A great advantage of the synchronous motor is that the entire load—the motor and all it may drive—since it moves in unison with the generator, acts as a fly-wheel for the water-wheel or steam engine which furnishes the power. It is exactly as if there were a line shaft from the generator to the motor, holding them rigidly together.

Step-up and step-down transformers add to the cost and complication of the plant and should not be used except for long distances. "I do not believe it would generally pay to use them for distances less than 10 miles." The use of fluid insulators on high tension lines is not always practicable. In some of the Western mountain districts poles have to be stuck up at all angles, and oil would spill out.

Mr. C. S. Bradley had worked with both three phase and two phase currents and preferred the three phase.

Dr. Louis Bell thought the great importance of simplicity should not be lost sight of. Step-up and step-down transformers are of course necessary for very long distances, but they are expensive, and it is a question whether this expenditure might not better be put in the line wire and the voltage reduced. The copper line wire is little subject to deterioration, while transformers do sometimes deteriorate.

Mr. Wm. Stanley said it might be interesting to know that a line of 15,000 volts is in operation in this country at Pittsfield, Mass.; about 20 HP. is transmitted, merely for experimental purposes. No difficulties whatever have been found at this potential; but the "striking distance" is apparently two or three times what it is at 10,000 volts. "We have undertaken to transmit 400 HP. for lighting purposes a distance of 28 miles at one place in this country."

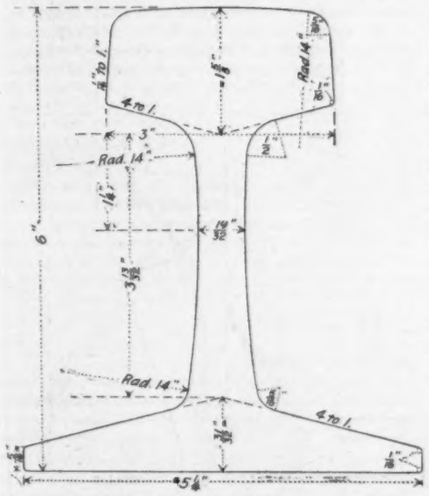
With reference to the synchronous motor, it has certain advantages, but a very serious defect is that if it is overloaded beyond a certain point it not only stops but burns up.

The transmission of power from Niagara Falls to Buffalo he did not believe was at present commercially practicable. If done at all it must be done by some such scheme as Prof. Thomson suggests, by using 100,000 volts potential and laying the wires in an oil pipe.

Mr. L. B. Stillwell differed with Mr. Stanley on this last point. Apparatus was now available for successful long distance transmission. He had recently made an estimate on behalf of the Westinghouse Co. for the transmission of several hundred horse power over a distance a few miles greater than from Niagara Falls to Buffalo and had been willing to guarantee the operation of the plant for a certain period after installation.

THE NEW YORK CENTRAL R. R. 100-LB. RAIL SECTION.

In our last issue, March 12, we described the new and substantial track which has been adopted by the New York Central & Hudson River R. R. for its four-track line from the Grand Central Station in New York to Mott Haven. This track will consist of steel rails weighing 100 lbs. per yd., laid on the steel ties illustrated in the article above referred to. We now present the section of the 100-lb. rail, and in a later issue we shall illustrate the form of joint, for the drawings of which we are indebted to Mr. Walter Katte, M. Am. Soc. C. E., Chief Engineer of the road. The rail conforms to the type of section of which a series was designed by Mr. P. H. Dudley, and patented by him in 1890. A set of standard rail sections for the New York Central R.R. system, including weights of 65, 70, 75, 80 and 100 lbs. per yd., has been selected from this series. The 100-lb. rail is very deep in proportion to its width of base, being intended for use on steel tie plates with wooden ties, and also for steel ties



100-Lb. Rail; New York Central & Hudson River R. R.

spaced 36 ins. apart, c. to c., this wide spacing making rigidity a very important feature. In the following table we give the dimensions of this rail in comparison with those of the 100-lb. mean type of section prepared from the average dimensions of the sections suggested individually by the members of the Committee of the American Society of Civil Engineers on "Standard Rail Sections" (Eng. News, March 21, 1891), and also with those of the Boston & Albany 95-lb. section (Eng. News, April 4, 1891).

	N. Y. Cen. 100 lb., ins.	Mean Sec. A. S. C. E. 100 lb., ins.	Bost. & Alb. 95 lb., ins.
Height	6	5 1/2	5 1/2
Width of base	5 1/4	5	5 1/2
" " head, top	....	2 3/4	2 1/2
" " " bottom	3	2 3/4	3
Slope of side of head	1/4 to 1	Vert.	1/4 to 1
Depth of head	1 3/8	1.672	1 1/2
Height of web	3 1/4	3.018	2 3/4
Depth of base	3/4	0.976	1
Thickness of web	9/16	0.69	5/8
Height to center of bolt hole	2 5/8	....	2 3/4
Radius of top of head	14	12	14
" top corners of head	1/8	3/4	1/8
Radius of bottom corners of head	1/2	1/2	1/8
Radius of top fillets	1/2	1/2	3/8
" bottom fillets	1/8	3/4	1/8
" corners of base	1/16	1/16	1/16
Radius of side of web	14	Vert.	14
Fishing angles of head and base	4 to 1	13°	4 to 1

THE CHIGNECTO SHIP RAILWAY.

The Chignecto Marine Transport Railway Co. held a meeting in London lately to consider a scheme for completing this work. The non-payment of January interest on the preferred shares was explained by stating that the contractors for the works, Messrs. Meiggs & Son, had undertaken to pay interest on these shares and debentures until the work was completed and accepted by the Canadian Government. They paid the interest on the debentures to Jan. 1, 1892, but they were compelled to suspend work and further payment owing to their inability to place the debentures in the English market during the prevailing financial crisis.

A report was submitted from Sir John Fowler and Sir Benjamin Baker, stating that about $1,046,325 would be required to complete the work. The Amherst terminal, based upon prevailing Canadian prices, would cost to finish $311,000; the Tidnish terminus, $224,975; railway, $216,015; stores, tools and plant, $9,570, a total of $761,650. The value of the material on the ground is put at $68,175, leaving $693,475 for works and construction. Mr. Ketchum's figures for the machinery and equipment, including freight, erection, etc., are $352,850, or a total of $1,046,325 as before given.

Sir Benjamin Baker stated that from an engineering standpoint everything was perfectly satisfactory. The machinery contract was sub-let to Messrs. Easton & Anderson, and as Mr. Anderson was now director-general of the ordnance factories, the company had all the advantage of his acknowledged technical skill in connection with the hydraulic appliances for raising the ships. All these designs have been carefully considered by Mr. Anderson. Mr. Ketchum stated that he left the work in perfect order, with 12 miles of single track of the railway laid, and six months' time would finish all the grading and masonry.

The outcome of the meeting was that a committee was appointed to confer with the directors as to the best means of raising funds, and, by completing the work, secure the subsidy of $175,000 per year for 20 years, which the Canadian Government would pay upon the acceptance of the work. This committee is to report on March 21.

THE SHEFFIELD RAILWAY STAND-PIPE.

The illustrations here given show a new automatic stand-pipe, or water-column, for use on railways. The leading features of this column may be described as follows: The column rotates at the base on a bearing of hardened steel balls, and part of this rotation is automatic, made so to insure a positive lock, parallel to the track, against any possible movement by winds or other causes. The main valve, shown in Fig. 2, is also automatic, and so arranged that the pressure in pipes can be utilized in opening and closing this main valve, an operation

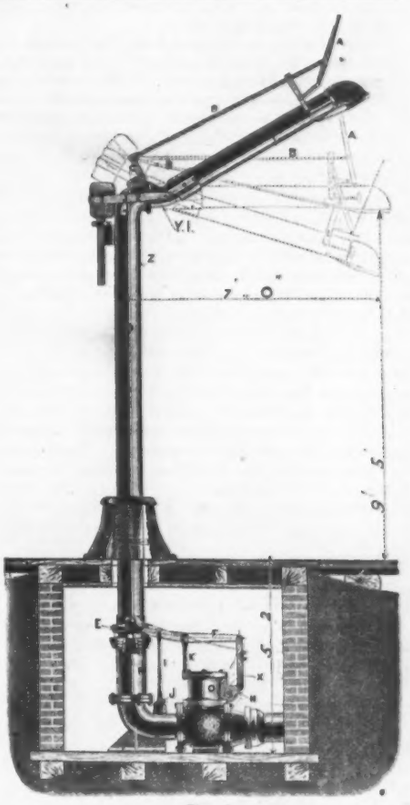


Fig. 1.

results, and the safety valve and air-chamber commonly used are not required. At the upper turn of the column a flexible spout of pure rubber, made proof against injury by cold by a special process, is introduced; the weight of the spout being carried by a system of lugs and levers, outside of the flexible part, and counterbalanced by an adjustable

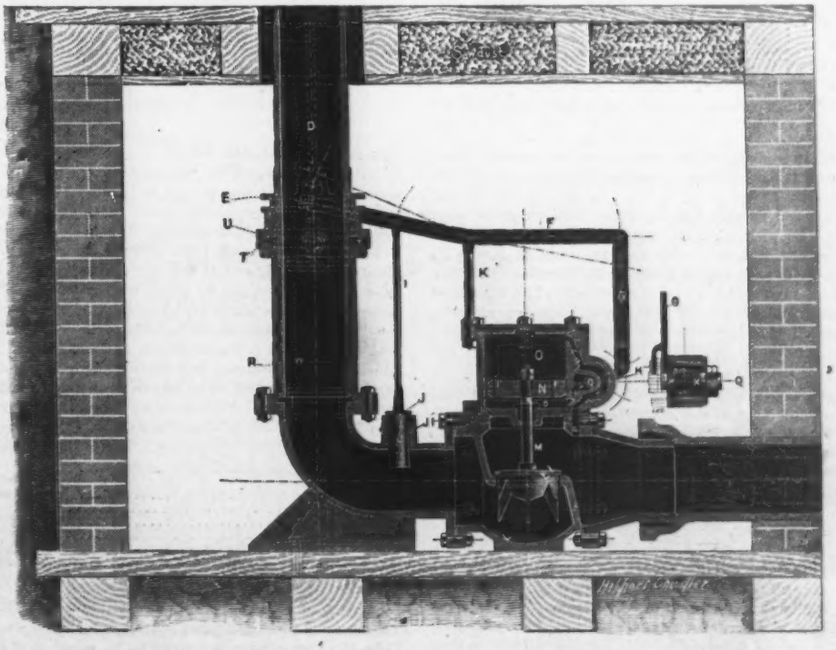


FIG. 2

heretofore accomplished by levers and screws. This valve is independent of the operating parts, and cannot be abused by those operating it, and the time of opening and closing can be easily regulated to suit pressure and other conditions. The valve is also provided with cut-off ports, with excellent re-

weight. This device admits of a great variation in height of tenders, and the spout can be adjusted to swing over the roofs of freight and baggage cars without moving the train. All drip is returned to the pit, and the column is made frostproof by a drain, operating automatically with the main valve

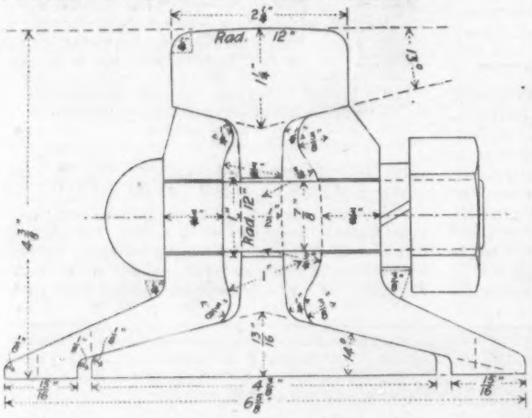
whereby the pipe is emptied in a few seconds. This drain can be closed in summer.

The stand-pipe is operated from the engine, by first drawing the spout around and lowering it over the manhole in the engine tank. Referring to Fig. 1, pulling the lever (A) operates the auxiliary valve (X) through the intermediate rod (B), bell crank (C) and two lower levers (F) and (H) and their connection (G). The same lever (A) also operates the drain valve (J), when this is desirable.

The main valve, as shown in Fig. 2, is represented as closed, the pressure from the water main acting upon the top of the piston (N), through the port (P^1), auxiliary valve (X) and port (P^2). By means of these two ports and the auxiliary valve the pressure can be applied either above or below the piston (N) and the main valve lowered or raised by the stem (M). The auxiliary valve is provided with a bridge which laps or covers port (P^1) when the main valve is being closed, and notches in this bridge regulate by their size the time of closing. This device makes this, it is claimed, the only water column that can be safely connected with city water mains and safely operated under ordinary city pressure. The operating parts are all on the outside of the pipe, are made of wrought iron in simple forms. All parts in contact with water are made of bell metal. These columns are sold by Fairbanks, Morse & Co., of Chicago, Ill.

STANDARD 60-LB. RAIL SECTION, QUEBEC CENTRAL RAILWAY.

The accompanying drawing, for which we are indebted to Mr. E. Berryman, Chief Engineer, shows to half scale the new 60-lb. rail section which has



60-LB. RAIL; QUEBEC CENTRAL RY.

just been adopted for the main line of the Quebec Central Ry. and the Megantic Branch. It will be seen that the section is very much like the "mean" section deduced from the individual suggestions of the Am. Soc. C. E. Committee on Standard Rail Sections, and published in our issue of March 21, 1891, but with slight differences, which may or may not be regarded as improvements. The standard joint used with this rail is a two-tie suspended joint, spliced with angle bars 30 ins. long; and four bolts, spaced 7, 6½ and 7 ins. c. to c. The joint ties are not less than 10 ins. wide.

All ties except at joints are spaced 2 ft. centers; the joint ties, 20 ins. centers. All rails for curves on this road are curved in a bending (roller) machine; no sledging or forcing allowed. The ties most used are tamarac and cedar, not barked. The ballast is sand and gravel, 10 to 12 ins. under the ties, 10 or 11 ft. wide at tie level. The engines weigh 65 tons in working order.

THE LEICESTER & SWANNINGTON RAILWAY, ENGLAND.

We have received from Mr. Clement E. Stretton, C. E., Leicester, of England, an illustrated pamphlet of a lecture delivered by him on this railway, which is one of the oldest in England. Mr. Geo. Stephenson, when asked to become the engineer, said he had 31 miles of railway to work, "and that is enough for any man at a time," but recommended his son, Robert Stephenson, who was appointed engineer, at the age of 27. From the pamphlet we take the following notes:

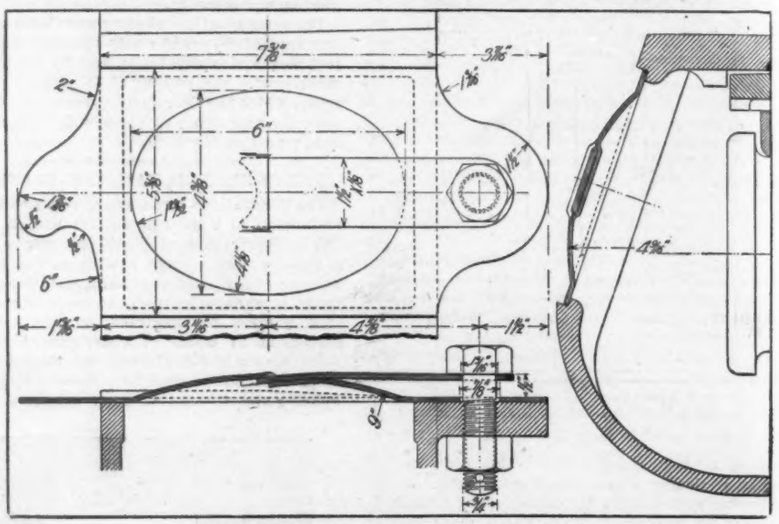
The company's Act was passed in 1830. The main line was 16 miles long, single track except at stations and the Bagworth incline. The grades were severe, but generally favorable to the loaded coal trains. There was a tunnel 1,798 yds. long, straight and level, and lined with brick. It was 13 ft. 6 in. high from the rails and 10 ft. 8 ins. wide at rail level. The gage was 4 ft. 8 1-2 ins. The rails were of wrought iron, of the fish-belly pattern, 15 ft. long, supported at intervals of 3 ft. in cast iron chairs resting on wooden ties or stone blocks. Each rail had three "bellies," 2 1-2 ins. deep at the chairs and 3 1-2 ins. deep at the middle; the head was 2 1-4 ins. wide. The Bagworth incline was about half a mile long, with a grade of 3.5 per cent., and the descending loaded coal trains hauled up the empty trains by means of a rope. The rope was of hemp, 1,000 yds. long, 5 ins. circumference, and cost $300. A new rope purchased in 1838 lengthened 30 or 40 yds. and varied in length by 6 to 8 yds. in wet or dry weather. The trains consisted of 10 or 12 loaded cars weighing 6 tons each. The Swannington incline, with a grade of 5.9 per cent., was operated by a stationary engine and hauling rope. Passengers were first carried in open cars without seats, but in 1832 a first-class car was built, 17 ft. long, weighing 2 1-2 tons empty, and divided into three compartments. The fare was 2 1-2 cts. per mile in the open cars, and 5 cts. per mile in the closed cars. For the former brass tickets or checks were used, which were collected by the conductor. When the second locomotive was put on the road, a 15-minute sand glass was employed at the Glenfield station and another at the tunnel house to prevent collision in the tunnel. When a train entered the tunnel the glass was turned, and if another arrived within 15 minutes it was stopped by a flag or candle. In 1839 there were 10 locomotives. The first of these was the "Comet," built in 1832, with cylinders 12x16 ins., four wheels 5 ft. diameter, and weighing 21,224 lbs. Later engines had six wheels, either four or six being coupled. The heaviest engine in 1839 was the "Hector," built in that year, with cylinders 16x20 ins., six driving wheels 4 ft. 6 ins. diameter, and weighing 38,080 lbs. The estimate cost per mile of single track was as follows:

Fencing	$1,075
Stone blocks	1,980
Wooden ties	3,300
Rails	4,620
Chairs	1,540
Tracklaying with blocks	880
Tracklaying with ties	660
Ballast and ballasting	440

The cost of construction of the main line was $39,850 per mile. For the three years ending December, 1839, the average profit was $43,240, equal to 6.17 per cent. on the capital. The maintenance was $653 per mile during that period. The cost for locomotives, including repairs, amounted to $10,500 per annum. The line was bought by the Midland Railway Co. in 1846. The present West Bridge Station, Leicester, with the board room over it, remains as it was at the time when George Stephenson and the other directors held their meetings. Nearly all the original documents remained until 1869, when it was reported that the cupboards were full of "old paper," and they were removed, some few to the railway offices at Derby, but most of them being destroyed. Mr. Stretton succeeded in getting copies of many of these valuable and interesting papers, and says that it was nothing unusual to see the fires at stations and at the engine shed lighted with letters by George and Robert Stephenson, with plans and profiles of the line and even with working drawings of the locomotives and cars. Six miles of the line near Leicester and 1 1-4 miles near Swannington remain practically unaltered, the Midland Railway having built deviations from the original line.

THE DREXEL PRESSED STEEL JOURNAL BOX LID.

The use of pressed steel in place of cast iron for journal box lids has become very general, the pressed steel lid being much lighter and stronger and requiring no grinding or dressing to make a dust tight joint with the face of the journal box. A recent design of pressed steel lid is that brought out by the Drexel Railway Supply Co., of Chicago, and illustrated in the accompanying drawing. The center of the plate is stamped up in a raised oval, upon the center of which the spring presses, thus distributing its pressure evenly. The spring is a flat piece of untempered spring steel, and is claimed to produce an extra heavy pressure on the lid. It cannot be set by rough usage in jerking open the lid, and it requires no careful adjustment in setting up. Should the spring break, the lid cannot fall but rests on the lower edge of the opening; and the insertion of another spring makes the lid as good as new. The lid can be used without alteration on the M. C. B. Standard journal box, adopted in 1890.



A NEW PRESSED STEEL JOURNAL BOX LID

ELECTRIC RAILWAYS WITH UNDERGROUND CONDUCTORS.

The electric railway systems in which the current is taken from underground conductors are described in the "Street Railway Journal," New York. The first of these has been put in by the American Engineering Co., of New York, on half a mile of track of the Brooklyn & Coney Island electric railway, and is described as follows:

In this system a wooden trench for receiving the transmitting main is located in the centre of the track. On the cappings are located every 12 ft. iron blocks, of very solid construction, which serve as contact plates or terminal heads. These project above the pavement about ⅜ in., the edges being beveled. Under the car is located a metallic brush long enough to extend from one plate to another. Each head is connected to a wire running to its own automatic switch in a distributing station, located in the center of each block. The car is started by throwing the current by means of a switch operated by hand into one or more of the heads. The connection is then so arranged that each head is automatically connected with the main as the car is passing over it, and the only por-

tion of the line alive is the head directly under the car at any time. The distributing boxes which are located about every 400 ft., may be arranged in the hollow part of a lamp-post. All feeders and mains are carried in the trench with the wires that are laid from the heads. At each junction box or elbow, where the wires from the heads go to the distributing station, a tap is taken from the main feeder and run to a binding post on each switch. An armature, part of each cut-out or switch, by an up and down movement, cuts in and out the main line with the head connected to that armature by being actuated by a magnet. A test of the system was recently made, and the trial was extremely successful. Whether the multiplication of electro-magnets rendered necessary by the construction will interfere with the continued operation is a question which can be answered only when a considerable length of road is in operation.

In the second system referred to there is a regular conduit between the rails. This is the system of the Love Electric Construction Co. and has been applied for a length of 1¾ miles on the Fullerton Ave. loop of the North Chicago Ry. Co. The contractors for the conduit were Christie & Lowe, of New York.

The construction is somewhat similar to the conduit used for cables. The yokes are 20 ins. deep and are placed 4 ft. apart, a cast iron lining being used between the yokes. The conduit is 15 ins. deep and 9 ins. wide. A special feature in the construction is a rolled steel slot rail with depending flanges to carry off the surface water. The rail is fastened by means of a clamp having a lateral adjustment. By the removal of the clamp and rail access may be had to the conduit at any point along the line. The track is laid with Johnson girder rail, weighing from 78 to 85 lbs. per sq. yd., and on the curves a 100-lb. rail of the same manufacture is employed. The electric circuit is entirely metallic. The two line wires, which are No. 000, B. & S. gage, are held in the conduit by insulators in jaws. Contact with the wires is made by means of a four-wheel trolley device, so arranged with springs that it yields to every motion of the car above. Contact is made and broken by means of a lever similar to that employed on a cable car. Power will be furnished from the Lincoln Ave. cable station, where an Eddy generator and a McIntosh & Seymour engine are located. The cars to be used on the line were built by the Pullman Company. Westinghouse electric motors and McGuire steel trucks will be used. The electrical construction work was done under the supervision of Professor Barrett, city electrician of Chicago, and the track construction was directed by the engineers of the North Chicago Ry. Co.

A run of 143 miles in 2h. 50m., without any stop, was made last week by the Chicago Limited Express on the New York Central & Hudson River R. R., between Albany and New York. As to speed this run is daily excelled by the Empire State Express, which covers the same distance in 2h. 30m., and is also more than the record-breaking run to Buffalo, last year, when Albany was reached in 2h. 20m. But these runs were made with comparatively light trains, while the Chicago Limited was made up of six of the heaviest cars in the service of the company. The Empire State Express makes the run of 439 1-2 miles, from New York to Buffalo, in 8h. 40m., an average of 50.71 miles per hour, including stops. One train load is about 175 tons. Comparing this with English runs, we have the 450 mile run of the London & Northwestern Ry. from London to Perth, in 9h. 50m., with an average of 45.76 miles per hour, including stops, and the run of 439 miles of the Great Northern Ry. from London to Perth, in 9h. 55m., at an average speed of 44.27 miles. These English trains weigh from 80 to 130 tons.

The U. S. Light-House Board, according to its last report, controls 1,167 light houses and beacon lights, and 28 light-ships in position. There are 1,368 post-lights on the Western rivers. There are 59 whistling buoys, 79 bell buoys, 6 electrically lighted buoys and 1 gas buoy in position, with 4,902 ordinary buoys. To attend to this apparatus requires 1,082 light-keepers, with 868 other employees and 1,126 laborers to care for the river post-lights. The total last general appropriation for this department was $2,337,000.

The parlor and buffet cars built in this country for the Southeastern Ry., of England, and which were fully described and illustrated in our issue of Oct. 10, 1891, were given a trial trip on March 2. The English papers comment very favorably upon these cars, and especially upon the heating arrangements, which maintain a uniform temperature of 60 degrees Fahr. It is not intended to run the cars as a special train, but to run them separately on express trains to the several seaside summer and winter resorts on the Southeastern Ry., and they will be available for passengers holding first-class tickets, without extra charge. The cars were built by the Gilbert Car Mfg. Co., Troy, N. Y.

English railways using the Westinghouse air brake will require all cars used in passenger train service to be fitted with the brake. The London, Brighton & South Coast Ry., and the London, Chatham & Dover Ry. have issued a notice to all other lines that they will not in future accept any cars, whether passenger cars, horse boxes, brake cars, etc., for conveyance by their passenger trains, unless fitted with the Westinghouse automatic brake apparatus.

The drainage question at New Orleans, La., is still unsettled, according to the following extract from the New Orleans "Picayune," March 7, referring to a meeting of the Council: The following communication was read from the City Surveyor: "At your request, I have examined the several propositions submitted on Feb. 18 for the erection of a drainage station to replace the present Bienville draining machine. Only two of the four submitted, viz.: those of Henry Worthington, of New York, and by Joseph Menge, of New Orleans, are accompanied by such plans as are called for by the specifications, and are necessary for the adoption of any plan, with the proper information concerning so important a work. I am not prepared to recommend the acceptance of Mr. Menge's proposition, owing to the temporary materials of which large and important parts of the plant are to be constructed. I think it is wise that this should be, as far as practicable, a permanent improvement. Concerning the proposition of H. R. Worthington, I can only say that the system is excellent, but that the cost largely exceeds the expenditure contemplated by the city. I, therefore, do not advise the acceptance of any propositions submitted." On motion of Mr. Brittin it was recommended that all bids be rejected for the reason that two of them were not accompanied with the specifications required. Of the other two, that of Worthington, of New York, called for $150,000 for construction, the appropriation being only $34,000. The bid of the Menge Co. was within the appropriation, but the material was of an inferior quality.

The School of Naval Architecture and Marine Engineering, lately opened as a department of Sibley College, Cornell University, is the first of its kind in the United States. Prof. W. F. Durand, late of the U. S. Navy, is the Principal, and the assistant is Mr. G. R. McDermott, lately with Messrs. J. & G. Thomson, ship-builders, of Clydebank.

The Richmond & West Point Terminal Ry. & Warehouse Co. will be reorganized under the name of the Southern Ry. Co., according to the plan of the committee appointed some weeks ago for the purpose of arranging the financial matters of the company. The plan provides for the issue of $170,000,000 of 4% first mortgage bonds (all but $10,000 of which is to be used for reorganization purposes), $70,000,000 of preferred 5% non-cumulative stock and $110,000,000 of common stock, making a total capitalization of $350,000,000. This capitalization is to cover the securities of the Richmond Terminal Co., the Richmond & Danville R. R. Co., and the East Tennessee, Virginia & Georgia R. R. Co., amounting to $394,572,101, exclusive of car trusts, for the retirement of which, as well as the floating debt, especial provisions are made. The total fixed charges under the proposed plan, including rentals, will be $7,660,000. The plan affords special privileges to the old stock and bond holders for subscribing to the new stock and bonds. The entire subscription has been guaranteed. In presenting its plan the committee uses this language: "We find that the various systems have not been operated throughout for the common benefit of the controlling interest, but that they have competed among themselves for business, each system maintaining separate organizations for obtaining business. This has necessarily resulted in a large diminution of net earnings of the property as a whole and in an increase of expenses. In the judgment of the committee, the only adequate remedy which can be adopted is to unite the several corporations as far as practicable in one system, under one management, and to consolidate their obligations. . . . In conclusion the committee desire to impress upon you that the failure of this plan will result in early default, receiverships, complicated litigation, a disruption of the properties and disaster to all the interests involved."

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF FEBRUARY, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.)				Wind.			Precipitation—(Rain and melted snow)—inches.		
						Velocity in miles per hour.					
		Average	Max.	Min.	Range.	Average	Max.	Direction at time of max. velocity.	Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	13.6	44	−19	63	7.4	32	S	1.73	0.92	10
	Portland, Me.	24.6	44	0	44	9.2	45	NE	2.18	0.90	11
	New York City	33.2	51	12	39	13.8	36	NW	1.27	0.53	9
	Pittsburg, Pa.	26.2	62	12	50	7.0	36	NW	1.85	0.48	15
	Chicago, Ill.	30.2	49	2	47	16.7	55	SW	1.57	0.42	14
	Omaha, Neb.	29.6	54	3	51	8.0	28	NW	0.54	0.21	8
	St. Paul, Minn.	20.8	42	−18	60	7.7	24	S	1.44	0.42	10
	Duluth, Minn.	17.6	50	−20	70	6.4	30	NE	1.46	0.58	14
	Bismarck, N. Dak.	11.4	48	−26	74	8.6	40	NW	0.55	0.13	11
	Average	24.7	49.3	−6.0	55.3	9.4	35.2	.....	1.40	0.50	11
Southern Cities.	Washington City	37.0	61	6	55	9.4	39	NW	3.64	1.61	12
	Louisville, Ky.	42.8	66	16	50	9.1	36	W	3.61	1.13	10
	St. Louis, Mo.	40.0	68	20	48	12.4	42	W	4.89	1.96	14
	Savannah, Ga.	54.4	75	32	43	8.6	30	NW	1.31	1.10	9
	Leavenworth, Kan.	36.4	61	12	49	9.0	36	NW	3.45	1.26	9
	Jacksonville, Fla.	58.6	78	36	42	8.2	30	SW	0.77	0.34	7
	Chattanooga, Tenn.	47.6	68	23	45	6.0	28	NW	3.61	0.91	10
	New Orleans, La.	60.6	80	43	37	8.6	29	SE	0.04	0.04	1
	Memphis, Tenn.	50.0	71	30	41	8.2	31	S	3.15	1.16	10
	Palestine, Tex.	58.6	90	34	45	6.5	29	SW	5.65	3.17	9
	Average	48.5	70.8	25.2	45.6	8.6	33.0	.....	2.97	1.21	9
Western Cities.	Helena, Mont.	32.4	54	6	48	8.0	48	SW	0.27	0.10	4
	Port Angeles, Wash.	40.6	52	28	24	4.9	45	SW	0.51	0.28	9
	San Francisco, Cal.	52.4	66	42	24	5.7	24	W	2.90	1.03	9
	Salt Lake City, Utah.	35.6	60	12	48	3.2	16	NW	0.68	0.21	12
	Denver, Colo.	33 5	63	3	60	8.3	34	NW	0.75	0.32	6
	Yuma, Ariz.	50.4	84	38	46	5.3	21	W	0.87	0.51	6
	Santa Fé, N. Mex.	34.8	54	12	42	6.8	33	SE	1.22	0.55	6
	Average	40.9	61.9	20.1	41.7	5.6	32.0	.....	1.06	0.40	7

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

FINDLAY, FT. WAYNE & WESTERN.—Work is now in progress ballasting the track laid by this company last year, and it is stated that construction will soon begin on a further extension from the Miami & Erie Canal to the Cincinnati, Jackson & Mackinaw R. R.

BALTIMORE & OHIO.—Surveys have been completed for a branch from Childs Station, near Elkton, Pa., to Quarryville, Pa., and it is stated that construction will begin within a month.

CHICAGO & WEST MICHIGAN.—A press dispatch says that the engineers of this company are running lines through Porter and Lake Counties, Indiana, for a proposed extension of this road to Chicago.

WESTERN NEW YORK AND PENNSYLVANIA.—We are informed that this company has built the following new iron or steel bridges since Jan. 1, 1892: No. 17, Canadea, N. Y., 132 ft.; Nos. 23, 24 and 25, Shippen, Pa., 90 ft., 103 ft. and 32 ft. respectively. The following new bridges are being erected: Sonyea, N. Y., 98 ft.; Tuscarora, N. Y., 108 ft.; Sherman, N. Y., 60 ft.; Clymer, N. Y., 60 ft., and McClintockville, Pa., 306 ft.

SANDUSKY & COLUMBUS SHORT LINE.—It is announced that plans have been completed for the construction of this road. Citizens of Columbus, O., are said to have taken a large amount of stock, and the road will be practically controlled by the Columbus, Shawnee & Hocking R. R. Co., according to the reports. The line runs from Sandusky to Columbus, O., 108 miles, and 13 miles from Sandusky to Belleview are completed. Ch. Engr., F. J. Ald, Marion, O.

NEW YORK CENTRAL & HUDSON RIVER.—It has been officially announced that the proposed repair shops will be constructed at Cheektowaga, just outside of Buffalo, N. Y., and the place called Depew. The cost of the work to be done at present is $900,000, but it is intended eventually to extend the work. The shops and yards will cover 100 acres of land. It is stated that work will be begun April 1 and be completed by July 15.

Projects and Surveys.

NEVILLE ISLAND.—A correspondent writes us that this project has been laid aside for other work, and that it is impossible to tell when, if ever, it will be taken up again. The road was projected to run from Pittsburg to Cornopolis, Pa., 14 miles.

PLYMOUTH & BOURNEDALE.—Chas. M. Thompson, Ch. Engr., Sandwich, Mass., writes us that there are some prospects that work will be commenced at an early date, but that nothing has been definitely decided upon. The line is projected to run from Plymouth, Mass., to a connection with the Old Colony R. R., about 15.4 miles.

CAMBRIDGE & CHESAPEAKE.—A correspondent writes us that this road will run from Cambridge, Md., through Church Creek and Woolford, Md., 25 miles. The route is through a level country, and the principal business will be in lumber, oysters and farm produce. Jas. Wallace, Cambridge, Md., Pres.

BLACK RIVER.—Ch. Engr. Geo. A. Ayre, of Perkinsville, Vt., writes us that this road as surveyed will run from Proctorsville, Vt., via Cavendish, Perkinsville, Springfield, Vt., and North Charleston, N. H., to Claremont Junction, N. H., 28 1-2 miles. The work will be heavy; maximum grade 90 ft. per mile, and maximum curve 12 degrees. There will be a 250-ft. riveted lattice girder bridge. The road will have a large local traffic in granite, soapstone and manufactured goods. Right of way is now being secured. The town has bonded itself for $40,000 in aid of the road, it is expected that other towns will do the same. It is expected to let the contracts about June 1, 1892, and to complete the road within a year from that date.

MIDDLESEX VALLEY.—It is stated that the $50,000 necessary to insure the building of this road from Naples to Stanley, N. Y., has been subscribed, and that the company will soon be organized to build the line. Frank B. Merrill, Canandaigua, N. Y., is at the head of the enterprise.

PENNSYLVANIA.—It is stated that Jennings Bros., of Lopez, Pa., will build a narrow gage railway from Lopez, Pa., toward Lovelton, Wyoming Co., Pa., 11 miles, to open up timber lands.

WILKES BARRE & EASTERN.—A correspondent writes us that this road is projected to run from Wilkes Barre, Pa., via Pinner's Mills, Yeatesville, Laflin and Moosic, Pa., to Stroudsburg, Pa., a distance of 60 miles, and that 18 miles have been surveyed. The route is through a mountainous country and the work will be very heavy, there being a large amount of rock work. There will be a large bridge across the Susquehanna River at Wilkes Barre. The company was chartered March 8, 1892. Pres., W. P. Ryman; Ch. Engr., I. E. Hartwell; both of Wilkes Barre, Pa.

ST. REGIS & SALMON RIVER.—This company has been chartered in New York State to build a railway from a point near Tupper's Lake to Malone, N. Y., with branches to Saranac Lake and other points in Franklin Co. Among the incorporators are John C. Yager, Frank G. Smith, Arthur G. Godfrey and others of New York.

Southern.—Existing Roads.

OXFORD COAST LINE.—A force of about 100 men is now at work on this 4 1-2 mile line from Oxford, N. C., to the Durham & Northern R. R. Ch. Engr., Ashton A. Chapman, Oxford.

BIRMINGHAM & JONES VALLEY.—Ch. Engr., C. O. Lagerfelt, writes the "Manufacturers' Record," that as soon as business arrangements are satisfactorily concluded contracts for construction will be let.

ORLANDO & WINTER PARK.—J. O. Fries, of Orlando, Fla., is reported as saying that work will be begun soon upon the proposed line from Oviedo to Rock Ledge, Fla., 43 miles, surveys for which were made in the summer of 1891.

FLORIDA SOUTHERN.—Notice is given that this company has been formed to operate a line of railway, partly constructed and partly to be constructed, from Palatka, Fla., to Charlotte Harbor, De Soto Co., Fla., with branches. The total length is about 300 miles.

ISBELL & IRON MT.—It is stated that work will be begun on this proposed railway from Isbell, Ala., to Iron Mt., 5 1-4 miles, about April 1. Pres., C. H. Castle; Gen. Mgr., J. B. Boyd; Sec., W. H. Nance; Contr., T. A. Clark. The offices will be at Isbell, Ala.

Projects and Surveys.

CHARLESTON, CLENDENNIN & SUTTON.—F. W. Abney, Charleston, W. Va., Pres., writes that this road is projected to run from Charleston, W. Va., through the coal and timber lands adjacent to the Elk River to Clendennin, W. Va., about 100 miles, and that its principal business will be the coal traffic. The right of way has been secured for 30 miles and the contract for construction let to Worthington, Elliot & De Bardeleben, Ch. Engr., Charles McDermott, Charleston, W. Va.

ST. ALBANS & COAL RIVER.—W. C. Reynolds, 232 Broad St., Charleston, W. Va., Ch. Engr., has begun the survey for this proposed railway from Charleston, W. Va., up the Coal River.

BARTOW & PLANT CITY.—Chartered in Florida to build a railway from Bartow to Plant City, Fla.

LOCKHART SHOALS.—At a recent meeting of the incorporators the following directors were elected: Chas. D. Farrer, Pres., Jos. Walker, C. E. Fleming, D. R. Duncan, C. D. Farrer, I. L. Hames, J. H. Spears, and W. H. G. Harris. It was decided to secure an engineer and have the proposed line from Jonesville, S. C., to Lockhart Shoals, S. C., surveyed at once.

POWELL'S VALLEY.—It is stated that a project is on foot to build a railway from Caryville, Campbell Co., Tenn., to Arthur, Claiborne Co., Tenn., about 35 miles. A. A. Arthur, Middlesborough, Ky., is interested.

ALABAMA & MISSISSIPPI.—C. E. Rodenburg has been elected President, and C. W. Mills, Secretary, of this company, whose incorporation was noted in our issue of Feb. 20. The proposed road is to run from Pickensville, Ala., to Columbus, Miss., and it is stated that 20 miles will be built at once.

MERIDIAN & TUSCAHOMA.—The "Manufacturers' Record" says: "Mention was lately made of the efforts in progress to secure the construction of the Meridian & Tuscahoma R. R. This road is projected to run from Meridian, Miss., via Pushmataha and Butler, Ala., to Tuscahoma, Ala., on the Tombigbee River. Charters were obtained from the states of Mississippi and Alabama, from the former as the Meridian & Brunswick R. R. Co., and from the latter as the Meridian & Tuscahoma R. R. Co., and these two companies consolidated under the last mentioned title. The main line is to be 45 miles long, 18 miles of which are in Mississippi and 27 in Aabama. Nothing beyond making surveys and estimates has been done. The company is capitalized at $200,000."

BRISTOL & NORTHERN.—This company proposes to build a railway from Bristol, Tenn., to Cleveland, Va., where connection will be made with the Clinch Valley Division of the Norfolk & Western R.R., a distance of about 35 miles. Geo. S. Bruce, of Bristol, Tenn., is Chief Engineer, and is now examining the route preparatory to making the surveys.

CONCORD & SOUTHERN.—The organization of this company has been completed by the election of the following officers: Pres., J. M. Odell; V.-P., R. W. Allison; Treas., D. B. Caltrane and Sec., W. M. Smith. The road is projected to run from Concord, N. C., to Monroe or Charlotte, N. C.

NEWPORT RY., HOTEL & IMPROVEMENT CO.—This company has completed its organization by electing John C. Robinson, Pres.; M. C. Staples, V.-P., and Wm. Marshall, Sec. The company proposes to build a railway from West Point, Va., to the Chesapeake Bay. The headquarters are at 1,104 1-2 East Main St., Richmond, Va.

ELIZABETH & PASQUOTANK.—This company proposes to build a railway from Norfolk, Portsmouth, Berkley or some other point on the Elizabeth River, Hampton Roads, Chesapeake Bay or Lynnhaven River, in Virginia, to some point on the North Carolina line in Norfolk Co., Va. Among the incorporators are Chas. H. Robinson and J. B. Flora, of Elizabeth City, N. C.

NORFOLK, WILMINGTON & CHARLESTON.—A recent issue of the Philadelphia "Record" contains the following information concerning this proposed railway: "The engineers of the projected Norfolk, Wilmington & Charleston R. R., whose offices are in this city, have completed the survey for the entire length of the road, 352 miles, and are now engaged in locating the line. Starting from Norfolk, Va., the surveyed route follows an almost air line to Charleston, S. C., passing through a section of country which is now almost without railway facilities. The surveys show that the construction will be easy, the greatest difficulty encountered being the Dismal Swamp, which the road runs directly through. From a point near Kingston, N. C., it is proposed to construct a branch to Columbia, S. C., a distance of nearly 250 miles, but this has not been surveyed yet. For 140 miles the heaviest grade will be 35 ft. to the mile, and for the remainder of the road 25 ft. to the mile. The country is very flat, and the heaviest work on the road will be the piling through the swamp district, the construction of five or six miles of trestling and the bridging of a number of rivers, the largest of which are the Pee Dee and the Santee. The road is expected, if built, to open up a fine lumber and trucking country, and to lessen the distance between the North and Florida by over 100 miles. Among the larger towns through or near which the route has been surveyed are Wallaceton, Va., Yardley, Coleraine, Windsor, Williamston, Packtolus, Dover, Washington, Point Caswell, Wilmington and Pender, N. C., and Conway, Fraser, Georgetown, Santee and McClellanville, S. C. The projectors hope to award the contract for building a portion of the line in a short time, and are now negotiating to raise the necessary funds, the cost of constructing the main line being estimated at about $6,000,000."

GLADESVILLE.—This company proposes to build a railway from Wise C. H., Va., to Big Stone Gap, Va., 5 miles.

Northwest.—Existing Roads.

CANADIAN PACIFIC.—A press dispatch from Winnipeg, Man., states that surveys will commence at once on the proposed line from Regina, N. W. T., south to the International boundary, where connection will be made with the extension of the Minneapolis, St. Paul & Sault Ste. Marie Ry., from Valley City, N. Dak., north. It is also stated that construction will begin as soon as the surveys are sufficiently advanced.

CENTRALIA & CHESTER.—Local papers state that this company is preparing to begin the construction of its line from Sparta, Ill., west, to Ste. Genevieve, Mo.

Projects and Surveys.

SPRINGFIELD, PAWNEE & SOUTHERN.—Chartered in Illinois to build a railway from Springfield, Ill., to Pinckneyville, Ill. Among the incorporators are: Columbus White, Saylorville, Ill., and C. E. Clayton and Hiram White of Pawnee, Ill., where the principal offices will be located.

ST. LOUIS & EAST ST. LOUIS TERMINAL.—This company has been chartered in Illinois to construct, lease and purchase a railway from a point in the city of East St. Louis, Ill., through St. Clair and Madison counties to a connection with the railways centering in East St. Louis and Madison, with such spurs and branches as may be required. Among the incorporators are: Isaac L. Morrison, D. W. Rider and Francis Hook of Jacksonville, Ill.

BAYFIELD, LAKE SHORE & WESTERN.—Chartered in Wisconsin to build a railway from Bayfield, Wis., northwest, to the Minnesota line. The headquarters will be at Bayfield, and the officers are: Pres., R. D. Pike and Secy., W. W. Downs.

Southwest.—Existing Roads.

HOUSTON & TEXAS CENTRAL.—The prospects seem good for the construction of the proposed extension from Albany to Anson, Tex., about 40 miles. The preliminary surveys have been completed and the line is now being located.

CHICAGO, BURLINGTON & QUINCY.—A dispatch from Kansas City, Mo., says that information has been received which indicates that work on the proposed extension from Bogard, Mo., west, to a connection with the Hannibal & St. Joseph R. R., at a point north of Liberty, Mo., 60 miles, will begin soon.

PAN AMERICAN.—About 14 miles of the grading from Victoria, Tex., south, have been completed, and work is rapidly progressing.

KANSAS CITY, NEVADA & FT. SMITH.—It is thought that work will begin about April 1 on the extension from Hume, Mo., south.

VELASCO & NORTHERN.—It is stated that this company, whose incorporation was noted in our issue of Feb. 20, has entered into a contract with the Brazos River, Channel & Dock Co. to begin the construction of its proposed line from Velasco, Tex., to Rosenberg junction, about 52 miles, within 90 days and to have the line completed within a year. Surveys are now in progress under the direction of Bernard & Donalson, of Velasco, Tex., Engrs.

VELASCO & SURFSIDE.—This company, whose incorporation was noted in our issue of Feb. 27, will be a branch of the Velasco Terminal Ry., and is to be completed by June 15.

MISSOURI, KANSAS & TEXAS.—At a recent meeting of the directors of the Missouri, Kansas & Eastern Ry. the following officers were elected: Pres., Edward C. Simmons; V.-P., Samuel M. Kennard; Treas., Lewis C. Nelson, and Sec., Geo. D. Dana. The route of the line will be from Franklin, Mo., near Boonville, Mo., east through Howard, Boone, Calloway, Montgomery, Warren St. Charles and St. Louis counties, to St. Louis, Mo., 180 miles. From St. Charles, Mo. to Hamburg, Mo., 16 miles, the line of the Cleveland, St. Louis & Kansas City Ry., now in operation, has been secured; also the partly graded line east from St. Charles, 26 miles, and west from Hamburg, 36 miles.

Projects and Surveys.

RICHMOND & ROCKY COMFORT.—Chartered in Arkansas to build a railway from a point on the Texarkana & Ft. Smith R. R., between Keller and Ogden, to Richmond, Ark., 5 miles, and thence to Rocky Comfort, Ark., 12 miles. It is stated that surveys will be commenced soon. The officers are: Pres., M. A. Locke; Treas., J. M. Head, and Secy., J. C. Head.

Rocky Mt. and Pacific.—Existing Roads.

NEVADA—CALIFORNIA—OREGON.—Surveys have been commenced for an extension from Amedee, Cal., north, and it is stated that construction will be begun soon.

GREAT NORTHERN.—Track is being laid east from Sand Point, Idaho, on the Pacific extension, at the rate of 3 1-4 miles per day, and the road is completed to a point half way between Sand Point and Bonner's Ferry. Track is laid west from Sand Point, 20 miles.

Projects and Surveys.

CALIFORNIA MIDLAND.—Chartered in California to build a railway from Sacramento to Fresno, Cal.

HUMBOLDT BAY & TRINIDAD LOGGING AND LUMBER CO.—This company proposes building 23 miles of logging railway in Humboldt Co., Cal.

GREELEY, ST. VRAIN & DENVER.—This Company has been chartered to build the proposed railway from Greeley, Colo., to a connection with the Burlington & Missouri River R. R. The officers are: Pres., H. C. Watson; V.-P., Geo. H. Young; Sec., H. G. Clark, and Treas., Jas. C. Scott.

SAN LUIS & SAN JOAQUIN.—M. M. Shaughnesay, 415 Montgomery St., San Francisco, Cal., Ch. Engr., writes that this road is projected to run from Port Hartford, Cal., via Cayucos, Paso Robles and Polonia's Pass, to Bakersfield, Cal., with branches to Tulare, Visalia and Fresno, Cal., a distance of 291 miles. About 90 miles will be through a rough country. The route is through a farming country. There will be one 700-ft. bridge and three 1,000-ft. tunnels. The preliminary surveys have been completed. John M. Wise, San Francisco, Cal., Pres.

Foreign.

CAMPECHE & MERIDA.—It is expected that this Mexican railway now building between Campeche and Merida will be opened for traffic as far as Tenobo within a few weeks and that it will be completed to Hecelchakan by next August.

GUADALAJARA & TEQUILLA.—A project is on foot to build a railway from Guadalajara to Tequilla, in the state of Jalisco, Mexico, 64 miles.

ELECTRIC RAILWAYS.

KNOXVILLE, TENN.—The Robertson Southern Electric Ry. Co. has been incorporated by F. A. R. Murphy and J. S. Stuart, of Knoxville, and A. J. Robertson and Henry Carey, of New York, to build a line with the Robertson underground system of conductors.

SAVANNAH, GA.—The City & Suburban Ry. Co. has awarded a contract to L. H. McIntire, of New York, for equipping 18 miles of track with the Thomson-Houston electric system.

LEAVENWORTH, KAN.—The Leavenworth Electric Ry. Co. has been incorporated by Geo. A. Baker, Wm. Dill and Lawrence Hawn, with a capital stock of $300,000, to build a line 15 miles long.

TACOMA, WASH.—Surveys and plans have been made for the electric railway to Sumner which is projected by Col. Frank C. Ross. Ogden & Bosworth, of Tacoma, are the engineers in charge, and expect to begin grading soon. The Point Defiance, Tacoma & Edison Electric Ry. Co. has awarded a contract to the Thomson-Houston Co. for the electric equipment of its road, which is 10 miles long.

CABLE RAILWAYS.

NEW YORK, N. Y.—The contract of the completion of the Third Ave. cable road has been awarded to Thomas E. Crimmins.

HORSE RAILWAYS.

NEWTON, MASS.—The Newton & Boston Street Ry. Co. has been incorporated by A. R. Mitchell, H. B. Parker and Jas. L. Richards, to build a line two miles long; capital stock, $50,000.

ALLEGHENY, PA.—The Millvale, Etna & Sharpsburg Ry. Co., with a capital stock of $300,000, has been incorporated by George B. Hill, G. W. Henderson and Joshua Rhodes, to build 12 miles of steel railway.

BEAVER, PA.—The Beaver & Vanport Street Ry. Co. has been organized by I. F. Mansfield, of Beaver, and A. D. Myers, of Beaver Falls. Capital stock, $15,000.

HIGHWAYS.

NEW YORK.—The Town Board of Hempstead, L. I., has been petitioned to macadamize 5 miles of the Moriches and Jamaica plank road.

COLORADO.—The Arapahoe County Commissioners, at Denver, have adopted a road improvement plan suggested by Commissioner Twombly, by which the County will purchase horse, plows and scrapers, the work to be under the charge of the Committee on Roads and Bridges.

BRIDGES, TUNNELS AND CANALS.

FRANKLIN CO., O.—Bids will be received for a two-span, Pratt truss, through bridge over the Scioto River in Franklin township. The length of the spans

will be 130 ft., width of roadway, 36 ft., and there will be two 6-ft. side walks. Bids will also be received for a single span, plate girder bridge 75 ft. long, with a 28-ft. roadway and two 6-ft. side walks. Address Henry J. Caren, County Auditor, Franklin Co., Columbus, O.

PARK CO., IND.—It is stated that the County Commissioners will build a highway bridge over the Wabash River at Montezuma. It is estimated to cost $30,000.

CANALS.—A canal six miles long has been surveyed from Burrard Inlet to Pitt River in British Columbia. lumbia.

WATER-WORKS.

New England.

ENOSBURGH FALLS, VT.—Works are talked of.

ARLINGTON, MASS.—The town has voted for authority to improve its works.

EVERETT, MASS.—The town has voted to apply for authority to issue $100,000 of bonds for extensions.

WEBSTER, MASS.—Engrs. Shedd and Searle, Worcester, have reported on works for the town, with pumping to a stand-pipe through a 12-in. main.

WHITMAN, MASS.—It is reported that the commissioners are considering the securing of a new or additional supply.

EAST PROVIDENCE, R. I.—The fire district is considering the building of works, water now being supplied by Pawtucket. Engr. S. M. Fray, Providence, estimates that works, with a water power pumping station, can be built for about $190,000.

WOONSOCKET, R. I.—It is reported that the council has appropriated $60,000 for improvements.

SOMERS, CONN.—There is talk of organizing a company to bring water from Gulf Brook, two miles distant.

Middle.

ALBANY, N. Y.—A bill has been introduced in the State Senate and Assembly providing for the abolition of the present water commissioners and of the special water commissioner and for the appointment by the Mayor of seven water commissioners. The bill provides for the expenditure of $500,000 for an additional or improved supply.

ATTICA, N. Y.—Application for a franchise for a second company has been made by Lewis Benedict and E. B. Wallis. A reservoir on West Hill is proposed.

DRUMMONDVILLE, N. Y.—Works are wanted.

FLORIDA, N. Y.—Engr. Joseph Rider, South Norwalk, Conn., has reported on a supply from a reservoir.

HANCOCK, N. Y.—The Hancock Water Co. talks of drawing a new supply from Sands Creek.

POUGHKEEPSIE, N. Y.—The Anderson Revolving Purifier Process, mentioned last week, will be given a trial in connection with the present filter beds. Supt. C. E. Fowler informs us. Water will be passed through the purifiers before going to the filter beds. The plant will have a daily capacity of 3,000,000 gallons. Water is pumped from the Hudson River.

NORWOOD, N. Y.—It is said that the village will soon have works.

SALAMANCA, N. Y.—The people will vote on buying the private works.

SOUTHAMPTON, N. Y.—It is reported that the Southampton Water Supply Co. will soon introduce water.

BELLE VERNON, PA.—Works are talked of.

MARTINSBURG, PA.—Wm. Nicodemus is treasurer of the recently incorporated Martinsburg Water Co.; capital stock, $20,000.

WEST PITTSTON, PA.—Borough works are talked of. The supply is now obtained from the company at Pittston.

DELAWARE CO., PA.—The following companies have been incorporated: Citizen's Water Co., Darby Borough; People's Water Co., Darby Township; Highland Water Co., Ridley Township; Penn Water Co., Sharon Hill; Tinicum Water Co., Tinicum Township; Consumers' Water Co., Upper Darby. Each company has the same incorporators, we understand, and each has a capital stock of $1,000, with $100 paid in. Address W. Y. Hooper, Media.

WASHINGTON, D. C.—Bids will be received by the District Commissioners until March 26 for cast iron pipe valves and specials.

Southern.

ALBANY, GA.—The city has voted, 531 to 26, for water-works and sewerage.

ATHENS, GA.—The people have voted for city works. The present plant is owned by a company.

EAST LAKE, ALA.—Works are still projected.

CANTON, MISS.—The Canton Water-Works and Electric Light Co. has been incorporated by Irwin Jamison, L. E. Conas and R. C. Perkins.

MONROE, LA.—A franchise for water and electric lighting plants has been granted to W. A. Bright and F. P. Granby.

NEW ORLEANS, LA.—It is reported that the Council has finally passed the ordinance allowing the company to issue $250,000 in bonds for a filtering plant.

North Central.

BRYAN, O.—A vote on the building of works will be taken at the spring election.

BEDFORD, IND.—It is said that works will be built.

BENTON HARBOR, MICH.—Bids are wanted until March 24 for two miles of 6 and three miles of 4-in., iron pipe, laying same, and furnishing and placing specials and hydrants. City Clerk S. D. Sharpe.

TECUMSEH, MICH.—The people have voted to bond the village for $35,000 for works.

EAST ST. LOUIS, ILL.—The East St. Louis Water Co. is having surveys made for works to supply Belleville by pumping from the Mississippi to a reservoir.

WILMETTE, ILL.—The village trustees have made a 10-years' contract with the Town of Evanston for a supply of water at 8 cts. per 1,000 gallons. Preparations are being made to expend $400,000 for water supply and sewerage systems.

EVANSVILLE, WIS.—The people will vote on issuing $25,000 of bonds for water-works and a town hall.

MARSHFIELD, WIS.—It is reported that the franchise noted last week has been amended so as to be acceptable to the Mayor.

NEENAH, WIS.—The Council has voted to submit to popular vote the question of building works. Estimated cost $60,000.

Northwestern.

REDWOOD FALLS, MINN.—Preparations are being made for the construction of works. Land has been secured. Water will be pumped from springs or wells near the Redwood River.

ST. PAUL, MINN.—Bids are wanted by John Caulfield, Secy. Water Comrs., until March 23, for 2,000 ft. 4-in., 25,706 ft. 6-in., 9,070 ft. 12-in., 7,800 ft. 16-in. cast iron pipe, and the privilege of ordering 1,700 ft. of 20-in. pipe; also for 50 tons specials and with the privilege of ordering all the specials needed.

LEAVENWORTH, KAN.—A section of the wall of reservoir No. 2 of the Leavenworth Water Co. gave way March 12, discharging 7,000,000 gallons of water, it is said, across the Missouri Pacific R. R. tracks.

PIERCE, NEB.—Works are projected.

DILLON, MONT.—Surveys for water and electric lighting plants have been made by Engr. Geo. Malthrop. J. F. Cowan, Butte, is interested.

EVANSTON, WYO.—The Council is considering plans for pumping machinery or a gravity system to supply the present reservoir. The Electric Light Co. has been doing the pumping but has given notice that it will discontinue after May 1.

SARATOGA, WYO.—Works are talked of.

Southwestern.

AUSTIN, TEX.—Plans for a 50,000,000-gallon reservoir in connection with the new works have been nearly completed by Engr. Werenskiold.

CORPUS CHRISTI, TEX.—The Council let a contract for works March 10 to Jager & McMullen. The supply will be from the Nueces River, said to be 15 miles distant. Cost, about $200,000.

CROWELL, TEX.—It is reported that works will be built.

HUBBARD CITY, TEX.—A scheme for works is on foot.

MONUMENT, COLO.—A reservoir, evidently for water-works, is proposed.

WHITE OAKS, N. MEX.—The White Oaks electric Light and Water-Works Co., with a capital stock of $40,000, proposes to supply the town with water and light.

Pacific.

MEDICAL LAKE, WASH.—Bids are wanted by Town Clerk J. F. Wood until March 29 for furnishing and laying about 7,948 ft. of 6-in. and 2,080 ft. of 4-in. Kalamein pipe; also for 15 hydrants, one 6-in. meter and all necessary specials; also for material and labor for a 900-ft. bridge, 7 ft. wide, to carry pipe across Medical Lake.

PUYALLUP, WASH.—Steward Rice, Tacoma, is interested in a project for another system of works.

SPOKANE FALLS, WASH.—The Water Commission has reported in favor of works to cost about $800,000. A water power pumping plant, reservoir and stand-pipe are recommended. City Engr., Oscar Huber.

SAN FRANCISCO, CAL.—It is reported that the Spring Valley Co. has bought land for a new high service reservoir.

ETIWANDA, CAL.—The Water Co. talks of improving its irrigation system, and of putting in pipes for domestic service.

TEMPE, ARIZ.—Engr. D. C. Henny, San Francisco, will report on water and electric lighting plants for the Tempe Land and Improvement Co. A pumping station and a reservoir are proposed.

Canada.

ESQUIMAULT, B. C.—The Esquimault Water-Works Co. is considering the question of securing a new supply.

ARTESIAN WELLS.

HITCHCOCK, TEX.—It is said that another well will be sunk.

ROCKPORT, TEX.—The sinking of a well has been suggested.

IRRIGATION.

RIVERSIDE, CAL.—The Riverside Heights Irrigation District has been organized. Priestly Hall and H. D. Noland are among the directors.

SAN QUINTIN, CAL.—Th Lower California Development Co. is having surveys for irrigation works made by W. Z. Earle.

NEW COMPANIES.—Brown Creek Irrigation Co., Camp Clark, Neb., $20,000; Nevada Canal Co., Littleton, Cal., $26,000; Burbank Land & Water Co., California; directors, L. T. Garnsey, F. M. Burbank and others, $50,000; Leamington Water & Land Co., Salt Lake City, Utah, Jos. D. Pardee, G. C. Richards and others, $100,000.

SEWERS.

BOSTON, MASS.—The contracts for building section 3 of the outfall sewer at Moon Island has been awarded to Perkins & White, at $71,904. The itemized bids were published last week.

CLINTON, MASS.—The town has voted $15,000 for additional sewers.

NANTASKET, MASS.—A contract has been awarded to Connolly Bros., of Beverly Farms, at $15,000.

NORTHAMPTON, MASS.—The Legislature has authorized the city to issue bonds for $100,000 for sewers.

SOMERVILLE, MASS.—The City Engineer shows in his annual report that 203 acres of the city are without sewerage.

HERKIMER, N. Y.—Plans and specifications for a new system have been prepared by F. K. Baxter, ex-City Surveyor. The separate system is proposed, and a pumping engine will be required.

READING, PA.—The Board of Trade urges the immediate building of a complete system. The Council has asked the City Engineer and C. P. Bassett, of Newark, to report how $75,000 can best be expended this year.

WILKINSBURG, PA.—The proposed system to empty into the Monongahela River, 2 1-2 miles distant, is estimated to cost $140,000.

CINCINNATI, O.—The Board of Administration asks bids until March 29 for sewers in two streets; until March 30, in one; until April 14, in one. The Commissioners of Hamilton Co. are authorized to issue bonds for $175,000 for the construction of a sewer from the terminus of the sewer in the Carthage Pike, near Fourth Ave., to Mill Creek.

CHICAGO, ILL.—Bids are asked by the Board of West Chicago Park Commissioners, until March 22, for 84 catch-basins and connections.

WILMETTE, ILL.—A system is projected which will send the sewage into the lake through the Emerson St. sewer. Estimated cost, including water-works system, $400,000.

HANCOCK, MICH.—Bids are asked until April 6 for 11,958 ft. of 8 to 24-in. vitrified pipe sewer. See advertisement.

MUSKEGON, MICH.—About 40 miles of laterals will be laid this year.

ST. JOSEPH, MO.—The Board of Managers of the State Lunatic Asylum No. 2 will spend $20,000 in constructing a main sewer.

FAIRHAVEN, WASH.—The City Council has asked bids for ten miles of sewers.

OLYMPIA, WASH.—Plans for a complete system are being considered.

STREETS.

BOSTON, MASS.—The Finance Committee has been requested to provide $85,000 for the improvement of Seaver St.

LENOX, MASS.—It is reported that $25,000 will be spent in macadamizing the main streets this summer.

HOLYOKE, MASS.—Bids are asked until April 1 for 3,000 sq. yds. of granite paving blocks, delivered. F. C. Steele, Chairman Highway Committee.

BROOKLYN, N. Y.—Bids are asked for grading and cobblestone paving; March 22, two streets; March 24, one street; March 25, one; March 29, one. J. P. Adams, Comr. Pub. Wks.

NEW YORK, N. Y.—Bids are asked until March 22 for grading, setting curbstones and flagging sidewalks in 144th and 145th Sts. and Ave. B. Maurice F. Holahan, Acting Comr. Pub. Wks.

PHILADELPHIA, PA.—Contracts for paving in eight streets have been awarded to the Vulcanite Paving Co.

BALTIMORE, MD.—The Mayor has signed paving ordinances for $225,000 for Broadway, and $500,000 for nine other streets. Bids are asked until March 22 for about 1,560,000 Belgian blocks, 24,000 lin. ft. of 6-in. curbstone, and 24,800 lin. ft. of gutter stones. A. E. Smyrk, City Comr.

LOUISVILLE, KY.—The bids for 1,700,000 vitrified brick have been rejected, and new bids are asked until March 26. H. S. Tyler, Mayor.

CINCINNATI, O.—The Board of Administration asks bids as follows: Until March 26, grading, curbing, guttering and bowldering one street; April 7, same with brick paving, two streets; April 8, brick, two; April 9, brick, one; April 12, brick, two; April 13, macadamizing, one.

TOLEDO, O.—Bids are asked until March 28 for paving one street with cedar blocks, vitrified brick or Trinidad asphalt laid on hydraulic cement concrete, together with the necessary grading, curbing, etc. C. H. Durian, City Clerk.

DETROIT, MICH.—The Board of Public Works has prepared a list of streets to be paved, the estimates aggregating $200,000.

SUPERIOR, WIS.—Contracts have been awarded as follows: Wolf & King, paving Winter St., $60,874; Wilson & Thatcher, West Fifth St. with Kettle river sandstone, $41,881; Keiver & Burke, Stinson Ave., $51,831.

ST. LOUIS, MO.—The Park Commissioner desires $100,000 for this year. Among other improvements he plans 1 1-2 miles of granitoid sidewalk.

OGDEN, UTAH.—The City Council has voted to issue paving bonds for $150,000. Three paving districts have been created, and notice of intention to pave the principal streets ordered.

ELECTRICAL.

GREENBUSH, N. Y.—The Village Clerk desires bids until March 22 for 175 incandescent lights of 25 c. p.

NEW ORLEANS, LA.—The committee on lights has voted to receive bids until April 4 for city lighting, arc lamps of 1,000 to 2,000 c. p., to be used and swung on arms 35 ft. above the ground. The contract will be for the existing number, 1,007 and 12 towers, and such additional lights as may be ordered.

FT. KLAMATH, ORE.—A franchise for an electric lighting plant has been granted to George J. Farnsworth, of Linkville.

NEW COMPANIES.—Bayonne City Electric Light & Power Co., Bayonne City, N. J.; $50,000; W. H. Peddle, Roseville,; R. Stewart and E. A. Dugan, Jersey City; Edgerton Electric Light Co., Edgerton, Wis., $6,400; F. W. Coon, M. Pelton and W. T. Pomeroy. Consolidated Electric Co., Burlington, Vt., $150,000; A. E. Richardson, U. A. Woodbury and Willard Crane. Pennock Electric Co., Los Angeles, Cal., $1,000,000; John P. Culvert, W. W. Robinson and Adolph Erdman.

CONTRACT PRICES.

PAVING SUPPLIES.—Boston, Mass.—The Street Department has awarded the contract for 300,000 large granite paving blocks to the Rockport Granite Co., at $73.90 per M., delivered on wharf. The contract for furnishing beach sand was awarded to James F. McIntosh, at 75 cts per ton.

BRICK SIDEWALKS AND GRADING.—Omaha, Neb.—The Board of Public Works has awarded a contract for brick sidewalks and tiling to J. O. Corby, at 12 cts. per sq. ft. for sidewalks and 14 cts. for tiling. Contracts for grading were awarded Katz & Callahan, at 11.8 cts. per cu. yd., and W. W. Mace, at 12.9 cts.

HARLEM RIVER DRAWBRIDGE.—New York, N. Y.—The Department of Public Parks received proposals March 9 for the construction of a drawbridge

over the Harlem River at 155th St., with the eastern approach thereto. The bridge will be built according to the plans and specifications of, and under the supervision of Mr. Alfred P. Boller, M. Am. Soc. C. E., Consult. Engr., New York, N. Y. The contract has been awarded to the Passaic Rolling Mill Co., Paterson, N. J., at $1,102,531. The following table gives the detail prices of bids:

Items.	Quantities.	T. & A. Walsh.	Arthur M c M illan.	Passaic Rolling Mill Co.	Union Bridge Co.	King Bridge Co.	Hart, Anderson & Barr.
Pneumatic foundations:							
Dredging per cu. yd.	6,000 cu. yds.	$1.00	$1.75	$1.75	$1.00	$1.00	$1.50
Pneumatic work complete per cu. yd.	13,872 "	37.80	34.50	36.00	38.00	38.80	40.00
Cofferdam:							
Cofferdam with masonry, per cu. yd.	2,000 "	2 .80	23.50	20.00	23.00	23.00	25.00
Fenders:							
Crib fenders, per cu. ft.	575,000 cu. ft.	6½ cts.	6½ cts.	7 cts.	6½ cts.	6½ cts.	6 cts.
Planking and bracing, M. B. M.	130 M. ft. B. M.	40.00	40.00	40.00	35.00	35.00	40.00
Piling:							
Piling, 40 ft per pile	200 piles.	8.00	8.00	7.00	7.00	7.00	9.50
" 40 to 60 ft., spans III.–VII., per pile	600 "	12.00	12.50	10.00	10.00	10.00	10.00
" 40 to 60 ft. " A–L, per pile	600 "	12.00	12.50	11.00	11.00	11.00	10.00
" 60 to 70 ft. " A–L "	720 "	12.00	15.00	15.00	15.00	15.00	15.00
Grillages, per M. B. M	207 M. ft. B. M.	40.00	35.00	40.00	35.00	35.00	40.00
Excavation and filling:							
Exca. and sheeting; piers IV.–VII., per cu.yd.	1,860 cu. yds.	2.00	2.00	2.50	2.50	3.00	3.00
" " A–L, per cu. yd..	4,000 "	1.65	2.00	2.75	2.50	3.00	2.00
Abutment and retaining wall, per cu. yd.	1,500 "	.80	1.00	.40	.50	.50	.50
Borrowed filling, per cu. yd	8,500 "	.70	.50	.40	.50	.50	.50
Grading excavation, per cu. yd.	500 "	.55	.50	.25	.50	.50	.25
Masonry:							
Concrete abutment foundations, per cu. yd.	200 "	5.60	6.50	5 50	6.00	6.00	10.00
Mortar retaining wall, per cu. yd.	2,675 "	5.80	6.00	4.50	5.00	5.00	7.00
Finished masonry (granite):							
Piers I. and III., per cu. yd.	2,500 "	25.30	24.00	21.00	24.00	24.00	25.00
Pier II., per cu. yd.	1,000 "	23.20	24 00	15.50	22.00	22.00	19.00
Piers IV. to VII., per cu. yd.	3,450 "	26.70	26.00	23.00	27.0	27.00	25 00
Piers A to L, per cu. yd.	5,314 "	24.8	26.00	16.00	24.00	24.00	25.00
Abutment, per cu. yd	650 "	23.50	22.50	15.00	25.00	25.00	25.00
Newels, piers IV. to VII., per cu. ft.	2,500 cu. ft.	2.60	2.00	1.90	1.90	1.90	2.00
Watchmen's houses, piers I. and III., each.	4 houses.	6,400	6,000	6,000	6,000	6,000	5,000
Newels for abutment, per cu. ft.	2,000 cu. ft.	2.60	2.00	1.75	2.00	2.00	1.75
Coping for abutment, "	600 "	2.25	2.00	2.30	2.00	2.00	2.50
" " piers A to L	5,115 "	2.25	2.00	2.30	2.00	2.00	2.50
" " retaining wall, per cu. ft.	1,800 "	2.40	2.75	2.30	2.70	2.70	3.00
Dressed surfaces, per sq. ft.	20,000 sq. ft.	.93	.85	.80	.86	.86	1.00
Metal:							
Draw span, per lb.	2,419,000 lbs.	4.9 cts.	4.14 cts.	4.64 cts.	4.14 cts.	4.45 cts.	4.23 cts.
Turn table, per lb.	750,000 "	6.5 "	6.60 "	6.54 "	6.60 "	6.00 "	6.38 "
Spans, piers III. to VII., per lb.	1,360,000 "	4.3 "	3.95 "	4.36 "	3.95 "	4.15 "	3.85 "
" piers A to abutment, per lb.	4,037,000 "	4.3 "	3.95 "	4.36 "	3.95 "	4.15 "	3.85 "
Machinery:							
Draw machinery and fixtures		$15,000	$14,800	$15,000	$14,800	$15,000	$14,800
Railing and lamps:							
Railing, rail box and cornice, draw, per lin. ft.	824 lin. ft.	23.00	21.00	21.50	15 00	20.00	21.50
" " spans III.–VII., per lin. ft	630 "	14.30	15.0	15.50	13.50	15.00	15.50
Single light lamps, draw, each	61	38.00	52.00	55.00	48.00	55.00	55.00
Cluster lamps, spans III.–VII., each	8	260.00	120.00	125.00	120.00	125.00	125.00
Gas mains, with tank, draw, per lin. ft.	1,500 lin. ft.	1.35	1.40	1.40	1.40	1.50	1.40
" " with branches, approved, per lin. ft.	2,000 "	1.30	.45	.45	.45	.50	.45
Ornamental work, draw		2.150	2,130	2,245	2,130	2,200	2,245
Cast iron gratings, draw, per lb.	25,500 lbs.	3.5 cts.	3.5 cts.	3.5 cts	3.5 cts.	4 cts.	3.5 cts.
Drainage gratings and spouts, each	20	16.00	30.00	30.00	30.00	35.00	30.00
Paving:							
Rock asphalt, sidewalks, per sq. yd	3,900 sq. yds.	2.25	4.00	2.75	3.95	3.95	4.00
" roadway, per sq. yd.	9,800 "	3.45	4.25	3.75	3.95	3.95	5.00
Sundries:							
Removal of present bridge		$4,000	$4,000	$4,000	$5,000	$4,000	$6,000
Extra cost of paint		6,300	3,500	4,500	3,500	4,500	4,500
Fitting up of engine room		2,375	2,250	2,50	2,250	2,300	2,250

Amounts of Bids for Above Quantities and Prices.

	T. & A. Walsh.	Arthur McMillan.	Passaic Rolling Mill Co.	Union Bridge Co.	King Bridge Co.	Hart, Anderson & Barr.
Pneumatic foundations	$152,931.60	$145,134.00	$150,942.00	$153,736.00	$156 833.60	$164,760.00
Cofferdam	47,600.00	47,000.00	46,000.00	46,000.00	46,000.00	50,000.00
Fenders	42,575.00	42,575.00	45,450.00	41,925.00	41,925.00	39,700.00
Piling	32,920.00	34,645.00	33,160.00	32,645.00	32,045.00	32,980.00
Excavation and filling	18,165.00	17,300.00	19,505.00	19,600.00	22,500.00	18,375.00
Masonry	16,635.00	17,350.00	14,137.50	14,575.00	14,575.00	29,725.00
Finished masonry (granite)	379,505.95	374,869.00	289,578.50	367,176.00	367,176.00	370,037.50
Metal	400,212.00	393,618.10	397,472.80	363,618.10	377,451.00	358,728.20
Machinery	15,000.00	14,800.00	15,000.00	14,800.00	15,000.00	14,800.00
Railing and lamps	40,480.50	37,664.50	38,738.50	31,519.50	37,020.00	38,738.50
Paving	42,994.50	57,865.00	47,947.50	54,707.50	54,707.50	65,260.00
Sundries	12,675.00	9,750.00	11,000.00	10,750.00	10,800.00	12,750.00
	$1,202,004.55	$1,162,570.60	$1,102,531.80	$1,150,452.10	$1,176,633.10	$1,186,874.20

PAVING.—Champaign, Ill.—The contract for paving South Neil St. and East University Ave. with brick has been awarded to the Urbana Brick Co. at $1.55 per sq. yd.

Atlanta, Ga.—The following bids have been received for paving Peachtree St.: J. A. Gillespie, granite blocks, $1.80, $2, $2.30 and $2.50 per sq. yd., brick, $1.98; A. R. Eckridge, brick, $.225; W. M. Lasley, Chattanooga, brick, $1.90, $2.35, $2.55, $2.60 and $2.65; M. E. Maher, brick, $2.86, granite, $2.61; H. T. Pope, asphalt blocks with maintenance for 5 yrs., $2.79, for 10 yrs., $3.09; R. S. Rust, brick, $2.23; Bowman Bros., McKenzie, Pa., brick, $2.35; S. B. Mosby & Co., brick, $2.87 and $3.87; Scharf Asphalt Paving Co., asphalt, $3.05 and $2.70.

IRON AND BRASS CASTINGS.—Boston, Mass.—The Water Commissioners have awarded the contract for 500,000 lbs. of iron castings and 150,000 lbs. service box castings to Osgood & Hart, at $1.95 per 100 lbs. The contract for 10,000 lbs. brass castings, composition No. 1; 25,000 lbs. No. 2; 8,000 lbs. No. 3; was awarded to Stephen Anderson, at 18, 15 1-5 and 14 1-2 cts. per lb., respectively.

CATCH BASINS AND CASTINGS.—Seattle, Wash.—The Washington Iron Works Co. has been awarded the contract for catch basins, manhole and handhole castings, at $19, $9.50 and $6 each, respectively.

PIPE AND CASTINGS.—Detroit, Mich.—The Board of Water Commissioners has awarded the contract for 3,000 lbs. of pipe and special castings to the Detroit Pipe & Foundry Co., at $22 per ton and $2.10 per 100 lbs., respectively.

CEMENT.—London, Ont.—The Water Board has awarded the contracts for Portland cement to John Mann & Co., at $3.20 per bbl.

WELL.—Boone, Ia.—The council has awarded the contract for an artesian well to J. P. Miller & Co. The well is to be 12 ins. diameter for 400 ft., and 6 ins. below that depth. The price is $8.25 per ft. up to 400 ft., then $3.50 up to 1,000 ft. with an increase of 50 cts. per ft. for every 200 ft. thereafter. The first 400 ft. is to be enclosed in wrought iron pipe and as much thereafter as may be required to prevent caving.

MISCELLANEOUS.

SUPPLIES AND ARMOR PLATES.—Washington, D. C. Bids are asked until March 22 for furnishing at the New York Navy Yard, 20,000 lbs. slab zinc, 9,788 lbs. galvanized iron, also rivets, etc.; at the Washington Navy Yard, 200,000 lbs. copper, 5,950 lbs. steel forgings, 10,000 lbs. tin, 5,000 lbs. slab zinc, also electrical and other supplies; at the Bath Iron Works, Bath, Me., 20,016 lbs. steel armor plates. Thos. J. Lasier, Acting Chief of Bureau of Provisions and Clothing, Navy Department.

STONE.—Memphis, Tenn.—Bids are asked at the U. S. Engineer's office until March 28 for furnishing and delivering 1,500 cu. yds. of rip-rap stone for Lake Bolivar, Miss.; 10,000 cu. yds. for Ashbrook Neck, Miss.; 15,000 cu. yds. for above Greenville, Miss.; 1,500 cu. yds. for Delta Point, La. Capt. C. McD. Townsend.

STONE DAM AND STEEL PIPE.—Syracuse, N. Y.—The Water Board has postponed the time of receiving bids for the work mentioned last week, from March 23 to March 30. The work includes taking down the State's stone dam in the outlet of Skaneateles Lake, lowering the foundation about 6-ft., and rebuilding the dam; also for taking down, moving and re-erecting the stone abutments of the bridge over the outlet of the lake at Main St., Skaneateles; also for dredging and deepening the channel and outlet, the former to a depth of 45 ft. for a length of 1,600 ft., and the latter to a depth of 14 ft. for a length of 8,000 ft.; also for constructing gate house, crib, trench, etc., and laying intake pipe. Bids are also asked for about 6,500 lin. ft. of single riveted steel pipe, including 8 to 16 flexible pipe joints, 54 in. internal diameter and 3-8 in. thick. The sections are to be 20 ft. in length and afterward riveted into lengths of 116 ft., the pipe to be coated with asphaltum.

IRON, STEEL AND STONE WORK, ETC.—Washington, D. C.—Bids are asked until April 5 for the iron columns, steel and iron floor, ceiling and roof construction, skylight roof complete, etc., for the public building at Newark, N. J.; also until April 8 for the excavation, foundations, cut stone and brick work, iron and wood floor and roof, etc., for the public building at San Jose, Cal. W. J. Edbrooke, Supervising Architect, Treasury Department.

PUBLIC BUILDINGS.—The House Committee has reported in favor of public buildings as follows: Brunswick, Ga., $75,000; Laredo, Tex., $70,000; Boise City, Idaho, $40,000; Suspension Bridge, N. Y., $75,000; Anniston, Ala., $40,000; Wilkesbarre, Pa., $100,000; Helena, Mont., $150,000; Hastings, Neb., $60,000; Waterbury, Conn., $100,000; Fond du Lac, Wis., $40,000; Chicago, Ill., repairing marine hospital, $30,000.

WHARF.—Ottawa, Ont.—Bids are asked until March 25 for the construction of a public landing wharf at Tracadie, Gloucester Co., N. B. Address E. F. E. Ray, Secy., Dept. Pub. Works.

GAS.—Salt Lake City, Utah.—The American Natural Gas and Oil Co. has awarded the contract for piping natural gas to the city from lake shore to Maj. C. T. Doxie, Anderson, Ind., for $500,000.

TROY, N. Y.—The contract for about 300 lights has been awarded to the Troy Gas Co. at 8 cts. per light per night.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., have an order for 100 freight engines for the New York Central. The Baldwin Locomotive Works, Philadelphia, Pa., are delivering 40 engines to the Baltimore & Ohio. The Cooke Locomotive Works, Paterson, N. J., have orders from the Louisville & Nashville and Houston & Texas Central.

CARS.—The Madison Car Co., Madison, Ill., has an order for 1,000 freight cars for the Chicago, Burlington & Quincy. The Buffalo Car Mfg. Co., Buffalo, N. Y., is building 500 double hopper gondola coal cars for the Lehigh Valley. The Mount Vernon Car Co., of Mount Vernon, Ill., has an order for 200 refrigerator cars for the Frost-proof Car Co. The New York, West Shore & Buffalo has added 500 box cars to its equipment.

VACUUM PUMPS.—Geo. E. Nye, of Chicago, Ill., has sold six of his steam vacuum pumps to the American Silica Co., Cleveland, O., for its new plant at Millington, Ill. Five are No. 4 pumps, capacity 30 cu. yds. of sand per minute, and one is a No. 6, 1,000 gallons of water per minute.

THE DREXEL CAR COUPLER CO., Chicago, Ill., will hereafter be known as the Drexel Railway Supply Co. Its specialties will be the Drexel M. C. B. type car coupler and the Drexel journal box lid, described on another page. Pres., W. A. Alexander; V.-P., A. C. McCord; Secy., A. Kilvert; Gen. Agent, H. O. Nourse.

THE CONGDON BRAKE SHOE CO., Chicago, Ill., is erecting an iron building, 200x110 ft., which will contain a 12-ton open hearth steel furnace and a 24-pot crucible steel furnace. It is expected that the plant will be in operation by June, making general steel castings and material for the Ross-Meehan shoes.

THE NORTHWESTERN EQUIPMENT CO., Chicago, Ill., has an order for 1,000 "Kewanee" rectangular brake beams for cars, being built by the Barney & Smith Mfg. Co., Dayton, O., for the Cleveland, Cincinnati, Chicago & St. Louis. The beams weigh 65 lbs. each. They have been adopted by the Keokuk & Western, and are being placed on 325 new cars by the Baltimore & Ohio. V.-P., E. F. Frost; Gen. Supt., C. L. Sullivan.

THE MEDUSALINE MFG. CO., is erecting a plant at Grand Crossing, Ill., for the manufacture of artificial stone and other materials under its patents.

NEW COMPANIES.—Washington Construction Co., Seattle, Wash., $250,000; Geo. Atkinson, B. Pell and E. B. Downing. Crossley Car Brake Co., Cleveland O., $25,0000; H. A. Crossley, J. P. Macbeth and S. Dean. New Power Co., Chicago, Ill., carbonic and gas motors $5,000,000; E. Noel, Wm. Zuetell and N. H. Hanchett.

TRADE CATALOGUES.—Manufacturers and dealers in goods pertaining to water-works and sewerage construction are requested to send copies of their catalogues to Louis Hawes, C. E., 75 State St., Boston, Mass., to aid him in replenishing and completing his list of trade catalogues.

CURRENT PRICE LIST.

RAILS.—New York: $30 at eastern mills; old rails, $20 to $20.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22 to $22.50 for iron and $16.75 to $17.25 for steel. Chicago: $31.50 to $32; old rails, $20 for iron and $13.50 to $14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 2 to 2.65 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagonal nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.15 to 2.2 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½% on black and galvanized butt-welded; 67½ and 55% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14 to $17.50. Pittsburg: $13.75 to $15. Chicago; $14 to $16.

LEAD.—New York: 4.15 to 4.2 cts. Chicago: 3.97 to 4 cts. St. Louis: 3.92 to 3.95 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.3 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.25 to 2.35 cts.; channels, 2.25 to 2.35 cts.; angles, 1.9 to 1.95 cts.; tees, 2.5 cts.; universal iron mill plates, 1.9 to 2 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined bars, 1.75 cts.; steel plates, 1.9 to 1.95 cts. for tank, 2.15 cts. for shell, 2.25 to 2.3 cts. for flange, 3.75 to 4.15 cts. for firebox. Chicago: beams, 2.25 to 2.5 cts. for standard, 2.57 cts. for small, and 2.7 cts. for 20-in.; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2.1 cts.; tees, 2.5 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.4 to 2.5 cts. for tank, 3.65 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.

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A few years ago the Chicago *Tribune* had only a couple of columns of these "small ads" every day and possibly two or three pages on Sunday. Now it has two pages every day and on Sunday it often has from eight to seventeen. The *Herald* of the same city often has eight pages on Sunday and the *News* generally has about two pages every day. In New York the *Herald* used to have a monopoly of this kind of advertising, running two or three pages a day and four or five times as many on Sunday. Now its patronage of this kind is easily doubled, while the *World* has still more and several other papers have a good patronage besides. This vast business has all grown up because half the people who want things publish notice of the fact, at the cost of a few cents, and the other half, having more time and less money hunt for what they want in the advertisements of others and generally find it.

A Chicago editor once bet a friend that he would get an answer to any want advertisement he would publish. A variety of "wants" were printed, and the editor lost his bet. Only one advertisement was unanswered. It asked for a purchaser for a set of second-hand false teeth. Some of the others got several hundred answers.—Tacoma (Wash.) Ledger.

WANTED—All consulting engineers, corporations, contractors, etc., to read Paret's advertisement about surveys. See page III.

WANTED—Continuous girders to calculate—either constant or variable Moment of Inertia—New Graphical method—My own invention. Address C. H. LINDENBERGER, Wayne Hotel, Detroit, Mich. 35-52t

WANTED.—Ex-chief engineer, Yale graduate, who understands Spanish and has had 18 years experience in United States, state, municipal and railway engineering work, and with credentials of the highest character, solicits correspondence with a view to an engagement. Address "X.," Engineering News. 4-15t

WANTED.—Graduate Civil Engineer, engaged several years at drafting, figuring and designing all kinds iron structures and bridge work, and who has been engaged in contracting all over the country, desires engagement with a reliable firm. If for taking contracts exclusively money only object. Address E. B. P., No. 118 Diamond St., Pittsburg, Pa. 9-6t

WANTED.—Roadmaster and graduate engineer, good manager and disciplinarian, thoroughly acquainted with the best practice, wishes to change location. At present with large trunk line. Wishes position as engineer maintenance of way or supervisor. Best references. Address R. R., Engineering News. 10-3t

WANTED—Position by civil engineer, age 35, good instrument man, topographer and draftsman, with experience in the design and construction of sewerage, water works, roads, harbor improvements, foundations and heavy masonry. Best references. Address STADIA, care Engineering News. 10-6t

WANTED—A position as rodman or chainman; am a fair leveler. Best of reference, will go anywhere. I want steady work, not large pay. Address W. H. CHRISTIE, Van Ettenville, N. Y. 10-6t.

WANTED—Indices to volumes 17, 21, 22, 24; will give 10 cents each for them.

WANTED—Engineering News for Jan. 7, Apr. 15, 1882; Dec. 29, 1883; May 30, 1885; July 13, 20, Nov. 30, 1889; Jan. 11, Mar. 15, 1890. Will pay 15 cents a copy. Put name on wrapper when sending papers.

WANTED—Bridge engineer, with 11 years experience, wants position. Perfectly familiar with making shop drawings, as well as estimates on all kinds of bridge and roof work. Address BRIDGE, care Engineering News. 11-3t

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WANTED—Position by a competent and energetic young man with three years' experience in city and railway engineering. First class with instruments and a good draftsman. Small salary. A1 reference. Address J. K. A., care of ENGINEERING NEWS. 11-3t

WANTED—Position on construction. Hydraulic work preferred; am competent to take charge of work. Good experience and first class references. A permanent position will be an object as well as salary. E. N. P., care Engineering News. 11-3t

WANTED—Situation by an engineer, aged 31. Railroad work preferred. Have instrumental outfit for both office and field. Neat and rapid draftsman. J. F. HUNT, 67 Sigourney St., Hartford, Conn. 11-3t

WANTED.—Young man, 27 years of age, six years' experience, at present employed on M. W. P. R. R., would like to change. Am well acquainted with transit, level and track work. Address M. W., care Engineering News. 11-3t

WANTED—A position as rodman, levelman or transitman by a young graduate in civil engineering. Will go anywhere in North or South America. Either temporarary or permanent employment desired. H. P. SIMPSON, Tuskegee, Ala. 11-3t

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WANTED—A steady position as locomotive engineer on some new road. Single; age, 23; three years' practical experience in railroad work; familiar with air and vacuum brakes; graduate of Mech. Engr. Dept. of Minn State University; good mechanical draftsman and willing to go anywhere in United States. Address A. H. A., 68 Summit Ave., St. Paul, Minn. 12-6t

WANTED—A position as foreman of granite yard, quarry or masonry work; 15 years' experience; reference furnished if desired. Address J. MORRISON, 87 Oak St., Lawrence, Mass. 12-3t

WANTED—Position as agent by an English mechanical and C. E. (resident this side six years) for manufacturer either at New York or Boston, or as manager or salesman. Address J. C. X., Box 672 New York City. 12 3t

WANTED—Topographical engineer and draftsman, experienced in field with plane table or any other instrument, familiar with all kinds of office work connected with it, having full first class instrumental outfit, desires engagement. Address "PLANIMETER," care Engineering News. 12 1t

WANTED.—A graduate of civil engineering from Yale desires a position in the East or South; has had considerable experience on preliminary, location and construction as rodman, levelman and transitman; at present with one of the large Western trunk lines. Address, E. F. M., care Engineering News. 12 3t

WANTED.—A young graduate civil engineer, experienced in railroad work, is open to engagement. Is a good draftsman and instrument man, and has had experience in designing masonry work, trestles, etc. Disengaged April 1. Address L. M., care Engineering News. 12 3t

WANTED—Copies of Engineering News for Sept. 27, Oct. 4, and Nov. 29, 1890. Will pay 25 cts. apiece for them. Must be in first class condition. Address this office.

WANTED.—Topographical engineer, 29 years' experience in railroad and canal construction, wants a position as first draftsman. Address L. H., ENGINEERING NEWS. 12-1t

WANTED—By an experienced resident engineer, now so employed, a position as resident or division engineer, South or Southwestern states preferred. One month's previous notice required. References, instruments, etc. Address H. F. (this office). 12-6t New York City.

WANTED—A first class city engineer and "all around surveyor" would like to locate in a growing town where a good practice could be assured, or would engage with a real estate syndicate. References. Address "EXPERIENCE," Engineering News Office, 12-6t New York City.

WANTED.—Surveyor (32), experienced in office and field work (land, city, topographical, hydrographic, mining), wants situation within or without the States; speaks Spanish; no objection to any climate. Address B. KARGER, 1416 Church St., San Francisco, Cal. 13 3t

TEMPLATE MAKER—Wants situation as foreman of template shop, or would work as journeyman in first class shop. Can give reference. Address J. P. BENNETT, No. 5624 Tracey Ave., Englewood, Ill. 13-3t

WANTED.—To Private Engineers and Surveyors—Young engineer of practical experience in masonry and wood work designing, mapping, etc., good field and office man, wishes to associate himself with engineer, with view to becoming partner or buying the business, if satisfactory. Address T., care Engineering News.

WANTED—By young man possessing executive ability, position as instrumentalist or as foreman or superintendent by contractor. References, last employer and others. Address BOX No. 76, Holbrook, Mass. 13-3t

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WANTED.—A civil engineer and expert draftsman, with experience on railroad and municipal work in field and office, wants engagement where push and strict attendance will secure permanency. Address "STABILITY," care Engineering News. 13-1t

WANTED.—Engineering News for Jan. 7, 14, 21, Feb. 4, 11, 18, 25, March 17, April 7, 1888. Will give fifteen cents a copy. F. A. D., care Engineering News.

WANTED—Engineering News for Aug. 1, 1885; Jan. 7, 1888; Feb. 6, March 9, July 13, 1889. Will pay fifteen cents a copy. VAN, care Engineering News.

WANTED—Position by a civil engineer and A1 topographical and mechanical draftsman. EUROPEAN GRADUATE, P. O. Box 25, Drifton, Pa. 13-3t

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WANTED—One or two competent draftsmen on shop detail work; best of references required; state experience and salary expected. Apply to J. R. WORCESTER, Chf. Engr. Boston Bridge Works, East Cambridge, Mass. 13 1t

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